DOCUMENT RESUME

ED 218 418 CE 031 208

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TITLE Engine Tune-up Service. Unit 2: Charging System. Student Guide. Automotive Mechanics Curriculum.
INSTITUTION Florida State Univ., Tallahassee. Career Education Center.
SPONS AGENCY Florida State Dept. of Education, Tallahassee. Div. of Vocational Education.
PUB DATE Jan 78
NOTE 72p.; For related documents see CE 031 209-222 and CE 033 108-109.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Auto Mechanics; Behavioral Objectives; *Electric Batteries; *Engines; Instructional Materials; Learning Activities; Postsecondary Education; Secondary Education; Study Guides; *Trade and Industrial Education
IDENTIFIERS Alternators; *Automotive Charging System; *Automotive Tune Up; Regulators (Electrical Equipment)

ABSTRACT

This student guide is for Unit 2, Charging System, in the Engine Tune-Up Service portion of the Automotive Mechanics Curriculum. It deals with how to test the charging system. A companion review exercise book and posttests are available separately as CE 031 209-210. An introduction tells how this unit fits into the total tune-up service, defines new terms, and provides work activities on the introductory information. Three performance objectives are covered: inspect, adjust, or replace fan belt (alternator belt); evaluate alternator and regulator output; and remove and install an alternator. Each objective is addressed in a separate section that includes these materials: introduction to the performance objective, performance checklist, list of tools and equipment needed to do the work activities for this performance objective, reading list, information sheets, and work activities that give hands-on practice in doing one part of the performance objective. (A charging system Graphic Diagnosis Chart is appended.) (YLB)

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ENGINE TUNE-UP SERVICE

Unit 2: Charging System

Student Guide

Automotive Mechanics Curriculum

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This public document was promulgated at a cost of $6,074.34 or $1.21 per copy to provide automotive mechanics instructors with curriculum materials to be used with vocational education students.

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ACKNOWLEDGMENTS

Developing and field-testing the units in ***Engine Tune-Up Service*** has been a mammoth task. Without the help of many individuals who generously contributed their time and knowledge, such an endeavor would not have been possible.

The Automotive Mechanics Curriculum Team is particularly indebted to its advisory committee: E. Miles Bacon, Consultant for Industrial Education, Region II; Martin Nelson, Pinellas Vocational-Technical Institute; Joe Hamlet, American Motorcycle Institute; Peter Mathey, Sarasota Vocational-Technical Center; Arthur Ballou, Director of Industrial Education for Dade County; and William Schipper, Ford Motor Company.

The team would also like to express its thanks to the instructors who tested Unit 2 in their vocational classrooms: Vernon Crotts and Jerry Bush, Lively Area Vocational-Technical School (Leon County); Royce Decker, Miami Lakes Vocational-Technical Center (Dade County); Myron Cost, South Technical Center (Palm Beach County); Keith Draper and Paul Storer, Daytona Beach Community College (Volusia County); and Roy Wires, St. Augustine Vocational-Technical Center (St. Johns County). A special thanks goes to the directors and administrators who allowed us to field-test these materials in their schools.

Other individuals who contributed to the publication of this book include Vicky Hula and Eleanor Feltser, who did the editing for the field-test version of Unit 2.

HOW TO USE THIS BOOK

As you work through this Student Guide, you'll find directions about when to do certain activities and when to use the Review Exercise Book. Be sure to follow these directions carefully since they lead you step by step to the completion of a performance objective.

Read the introduction on page 1 before you start working through this Student Guide. It will tell you how Unit 2, ***Charging System,*** fits into the total tune-up service. There are also separate introductions to each performance objective. These introductions give you the basic concepts and terms you'll need to know before you begin work.

Performance Objectives

The performance objectives (abbreviated *P.O.*) in this Student Guide are statements of what you'll need to do on the job. All the materials in the Student Guide and in the Review Exercise Book are carefully designed to help you do well on performance objectives. So be sure to complete all the activities, and try to do well on each of them.

After you have finished all the activities for a performance objective, your instructor will test you to see whether you have mastered the necessary skills. A performance checklist will be used to check your work. Each introduction to a performance objective includes a copy of the checklist. Be sure to read it so that you'll know exactly what you'll be tested on.

A list of tools and equipment that you'll need is also provided in the introduction for each objective. If you want more information about a performance objective, be sure to refer to the reading list in that introduction.

Work Activities

You'll need to check with your instructor before and after you do any work activity. Automotive mechanics is a hazardous trade. That's why it's important for you and your instructor to be sure that you do the work activities safely. Each work activity gives you "hands-on" practice in doing one part of a performance objective. Do each work activity as required in the Student Guide, and you'll find it easier to do the complete performance objective later. Never hesitate to ask your instructor about anything you're unsure of in a work activity.

Review Exercise Book

As you work through this Student Guide, you'll frequently be directed to complete an exercise in your Review Exercise Book. Before you begin the first exercise, read the introduction at the front of the Review Exercise Book. The introduction gives you information about how to use the book so that you'll get the most out of it.

Pretest

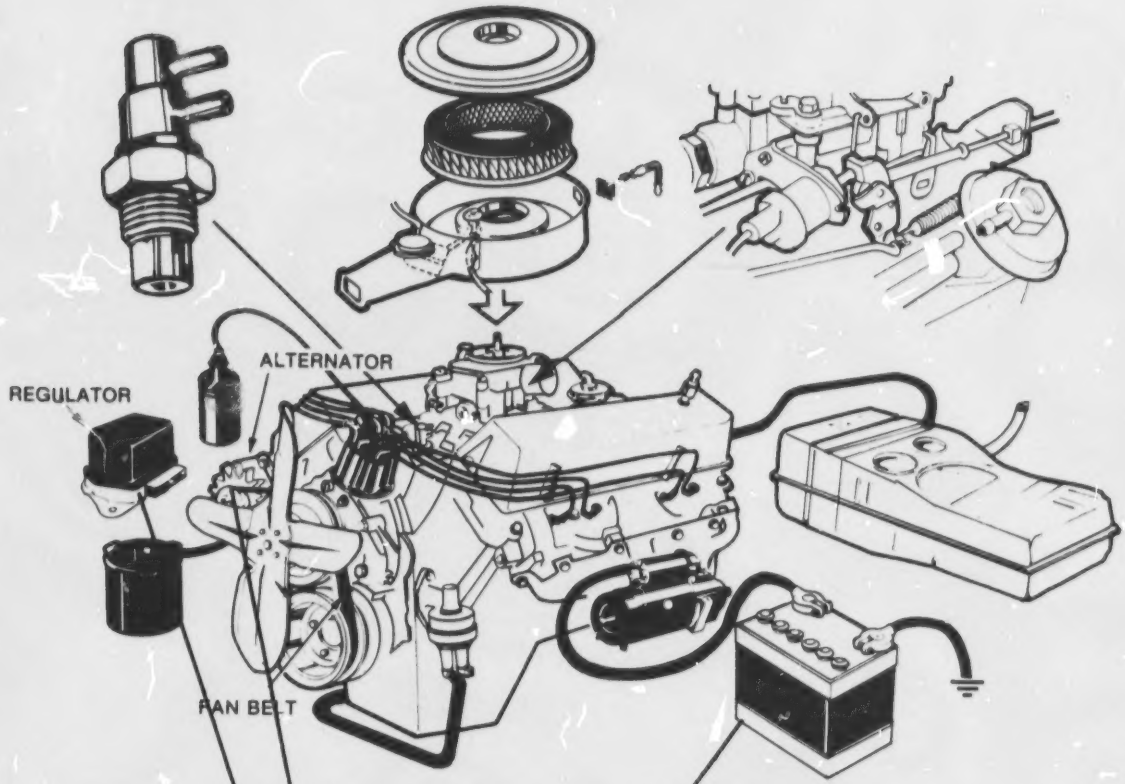
Before you go any further, ask your instructor whether you can take the pretest for Unit 2. The pretest will let you know what to look for in these materials. If you do well on the pretest, your instructor may let you skip some of the study material in the Student Guide.

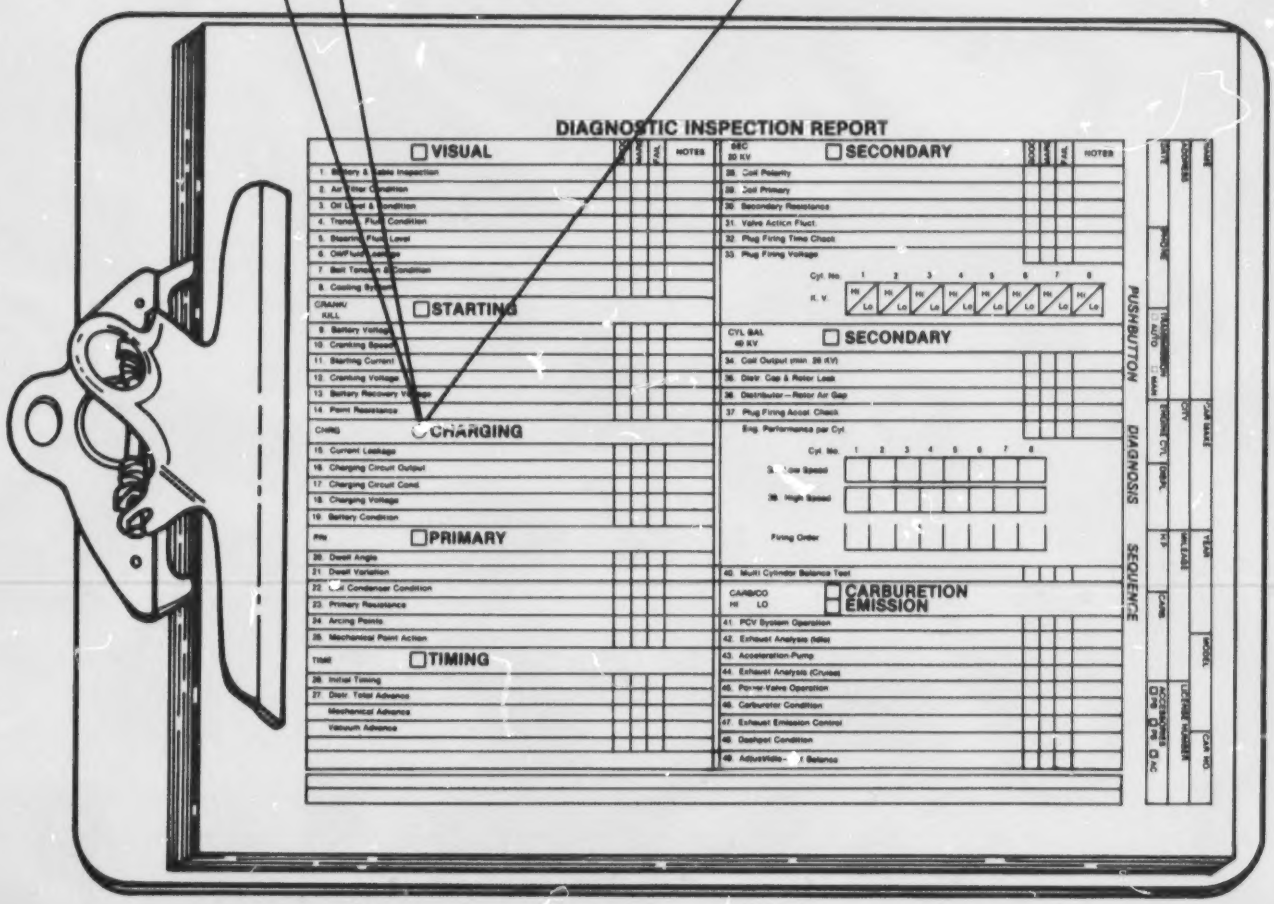
Your instructor will let you know when to begin studying the materials in this Student Guide.

Good luck!

INTRODUCTION TO UNIT 2

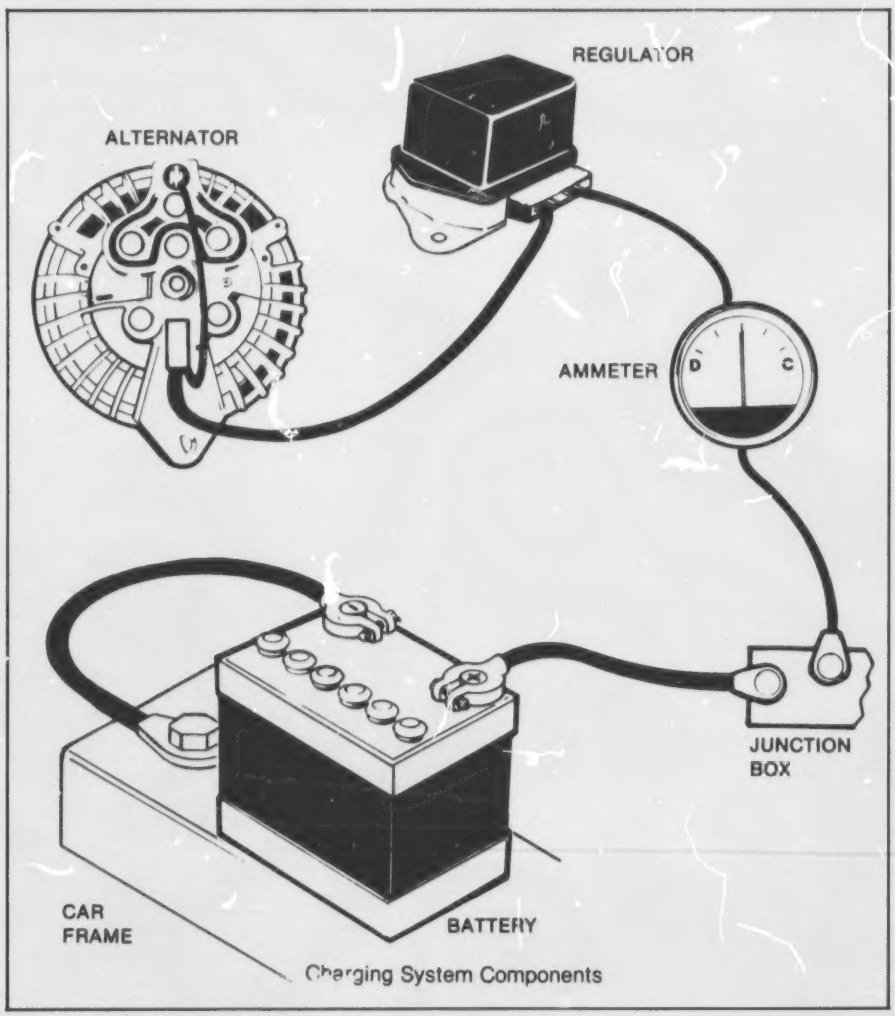
This unit deals with how to test the charging system, the next step in the total tune-up service. You'll be doing adjustments, repairs, and replacements on the charging system as required. But before you begin work on the first performance objective, you need to know what the charging system is and how to identify the parts and wiring that make up the circuit.


ALTERNATOR
REGULATOR
FAN BELT


DIAGNOSTIC INSPECTION REPORT
VISUAL
STARTING
CHARGING
PRIMARY
TIMING
SECONDARY
SECONDARY
CARBURETION
EMISSION
PUSHBUTTON DIAGNOSIS SEQUENCE

The Charging System

When the cranking motor is turned on, it draws current from the battery. The charging system has the job of putting current back into the battery after the engine starts. Without a charging system, the battery would be drained of energy and the automobile would stop running. The charging system also provides current for the vehicle's electrical parts such as the ignition system, lights, and accessories. Since the charging system affects all the electrical components in the vehicle, it is important to check and service its parts regularly.



Charging System Components

The charging system is made up of the following parts:

Battery The source of voltage. Its condition is important to the operation of the charging system.

Battery cables The main electrical cables that connect the battery to the charging system.

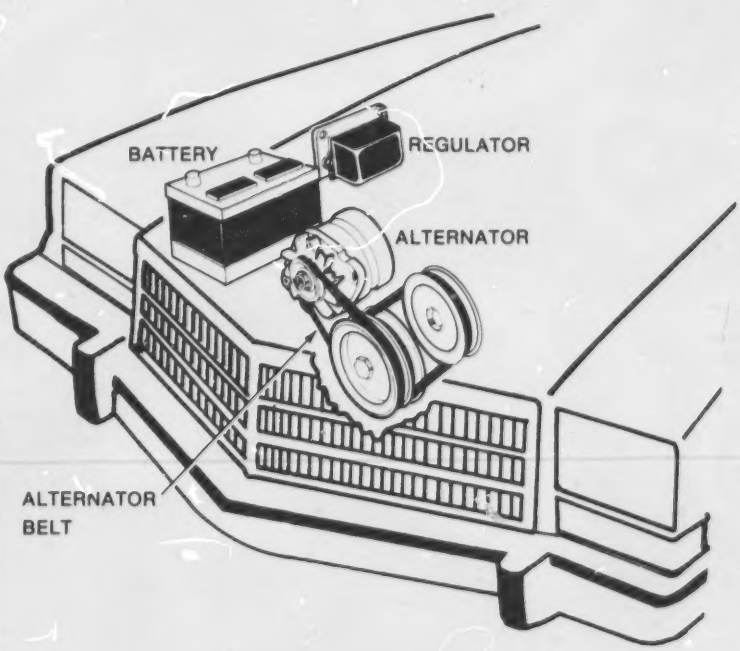
Alternator The device in the charging system that keeps the battery charged.

Alternator belt The device used to drive the alternator and water pump as the crankshaft pulley turns. It is also known as a fan belt or V belt.

Regulator The device in the charging system that controls alternator output to prevent excessive current from damaging the battery or the alternator.

Connecting wires The battery cables and the wires leading to the junction box, ammeter or indicator light, regulator, and alternator.

You can see the major components of the charging system in the picture below.



Charging System on an Automobile

Operating Principles

The alternator is mounted on the front of the engine, located either on the left or right side. The alternator is driven by the alternator belt when an automobile starts. This belt is connected from the alternator pulley to the crankshaft pulley. When the engine is running, the crankshaft turns and makes the alternator belt turn with it. The other end of the alternator belt turns the alternator pulley.

The alternator pulley causes a rotor in the alternator to rotate. As the rotor turns, it contacts conductors and causes current to flow. As the current in the alternator builds up, the regulator begins to regulate the current to keep the battery charged and to keep from damaging other components of the system.

The electrical current produced by the alternator keeps the battery charged. It also provides electricity for the other electrical components in the vehicle.

As you know from Unit 1, the battery should always be checked first when problems develop in the electrical system. If the battery or other components of the cranking system are not defective, check the charging system next.

New Terms

Alternating current An electric current that flows through the circuit first in one direction and then in the other. This alternating motion goes on rapidly and constantly during operation.

Direct current Current that flows one way only, rather than in alternating directions.

Field The area in space that surrounds a magnet. It is filled with magnetic lines of force.

Field circuit The section of an alternator that strengthens the flow of current.

Field current Current that flows through a field winding in an alternator.

Field coils Insulated wires wrapped around an iron or steel core. Field coils help to strengthen the flow of current in the alternator.

Field windings Same as field coils.

Turn to your Review Exercise Book and complete Exercise 1.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you're not sure that you can do a work activity, ask your instructor for help.

1. Draw the vehicle's charging system and label all parts and wiring, including the circuit grounds. (pages 3-4)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

2. Look at several vehicle engine charging systems and identify the parts and wiring that make up the system. (pages 2-4)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

When you have finished these activities, go on to the next page.

PERFORMANCE OBJECTIVE 5

INSPECT, ADJUST, OR REPLACE FAN BELT (ALTERNATOR BELT)

INTRODUCTION TO P.O. 5

In this section, you will read about ways to inspect, adjust, or replace a fan belt. Because there is more than one belt at the front of the engine, and each drives one of the engine accessories, procedures in this performance objective deal specifically with the alternator belt.

After you have finished all the work activities for Performance Objective 5, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 5

The instructor will provide a vehicle on which the student can remove and replace the alternator belt. All necessary tools, equipment, and manuals must be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Loosens the alternator adjusting (cap) bolt.			
2. Loosens the alternator mounting bolt.			
3. Moves the alternator toward the engine.			
4. Removes the belt and inspects it for damage or wear.			
5. Checks the pulleys for burrs and rough spots.			
6. Installs a new (or old, if okay) belt over the pulleys.			
7. Using a suitable pry, pries the alternator outward from the engine.			
8. Checks the belt tension against specifications, using a belt tension gauge.			
9. Tightens the alternator adjusting bolt.			
10. Tightens the alternator mounting bolt.			
11. Uses proper tools and equipment.			
12. Follows all safety precautions.			
13. Time.			

SAMPLE

Tools and Equipment

You will need to use the following tools and equipment when you do the work activities for Performance Objective 5. You should already be able to use a basic hand tool set, so no procedures are provided here. The procedures for using special tools and equipment, however, will be provided as you work through the activities in this Student Guide.

Basic Hand Tool Set

Special-Purpose Hand Tools

belt tension gauge
lever (pry bar)

Basic Equipment

fender covers
extension light

Safety Equipment

eye protection

Reading List

The Student Guide has been carefully designed to provide you with only the information you need to know to complete each performance objective. If you would like additional information, however, you may wish to use the references below.

General References

Ellinger, Herbert E. ***Automotive Systems: Fuel, Lubrication, and Cooling.*** Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1976, p. 176.

Stockel, Martin W. ***Auto Service and Repair.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975, p. (19–9).

Personal and Service Safety Practices

Safety When Working around Alternator Belts

- A runaway (driverless) vehicle can cause severe personal injury and property damage. Follow these safety procedures to prevent a vehicle from accidentally moving:
  - Put the parking brake on.
  - If the vehicle is equipped with automatic transmission, put it in park.
  - If the vehicle has a manual transmission, put it in neutral.
  - Block the wheels with wheel chocks.
  - Remove the key from the ignition lock.
- Always use fender covers when you work under the hood, since tools, equipment, and belt buckles can scratch the finish on the fenders.
- Always use seat covers (cloth). This prevents you from soiling the seat upholstery.
- Always use a steering wheel cover. This will keep the steering wheel from getting greasy.
- Never put tools in your pockets. This can damage the seat upholstery and car finish.
- Keep your hands clean by wiping them frequently. Greasy, slippery hands are dangerous hands.
- When adjusting the alternator belt, take care not to damage the light aluminum end frames of the alternator. The pry bar should be placed against the midsection of the alternator, known as the stator.

Safety in Work Clothing and Grooming

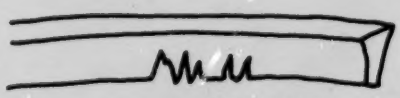
- Avoid wearing loose clothing or anything that can hang down and get caught in the moving parts of an operating engine. Injury can result. Loose clothing can also catch on engine parts and tear.
- Leather shoes will protect your feet against injury caused by dropped objects, battery acid, hot water, and other hazards. A "safety toe" shoe is ideal. Bare feet, sandals, and thongs are not acceptable. Shoes should be fully secured on the feet and laces tied.
- Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that can come in contact with electricity. You can receive a severe burn if the metal you are wearing touches an electrical part.
- Keep hair away from the moving parts of an operating engine. Keep your hair under a hat if it is longer than conventional length (reaches over your shirt collar).

Inspecting the Alternator Belt

The alternator belt (commonly called the ***fan belt)*** connects the alternator to the crankshaft pulley. You should always check this belt for ***tension*** (tightness) and ***wear.*** It's important for the belt to work properly, or the alternator may not work. You can tell a worn belt by cracks or frays on the belt. Worn alternator belts should always be replaced.

FIGURE 5-1 Worn fan belts with cracks and frays

FRAYED BELT



CRACKED BELT

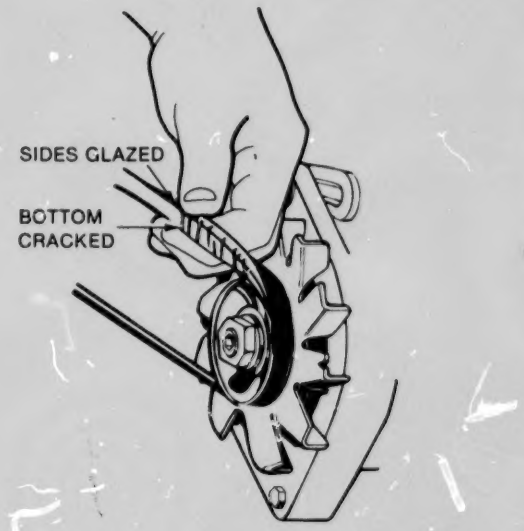
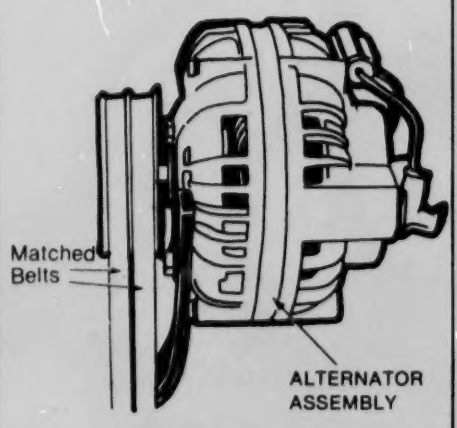


FIGURE 5-2

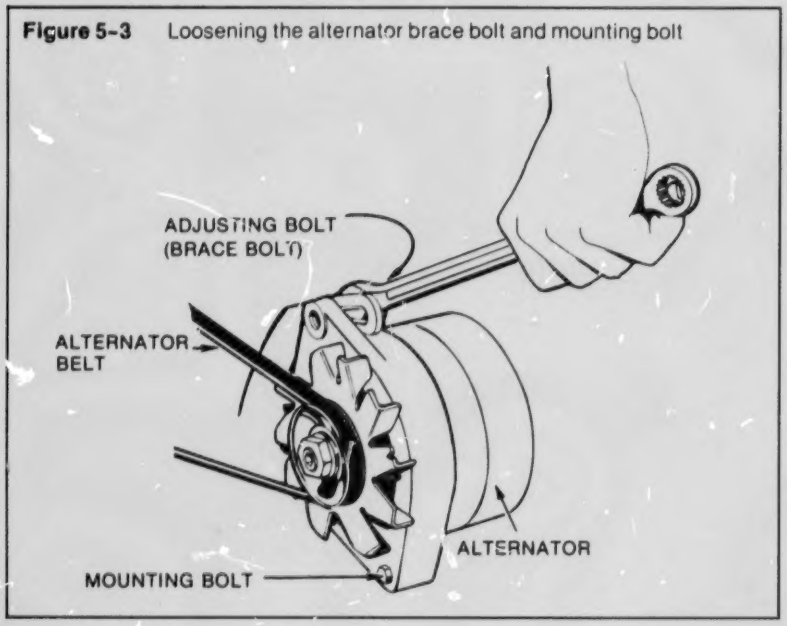


Some cars have two fan belts running parallel. These are called ***matched*** belts. If just one belt is replaced, the new belt will wear faster because it's not stretched like the old belt. This may cause the old belt to slip, overheat, and wear rapidly. Since the two belts affect each other, they must be kept in the same condition to work properly. For that reason, ***always replace both belts of a matched pair.***

Removing the Alternator Belt

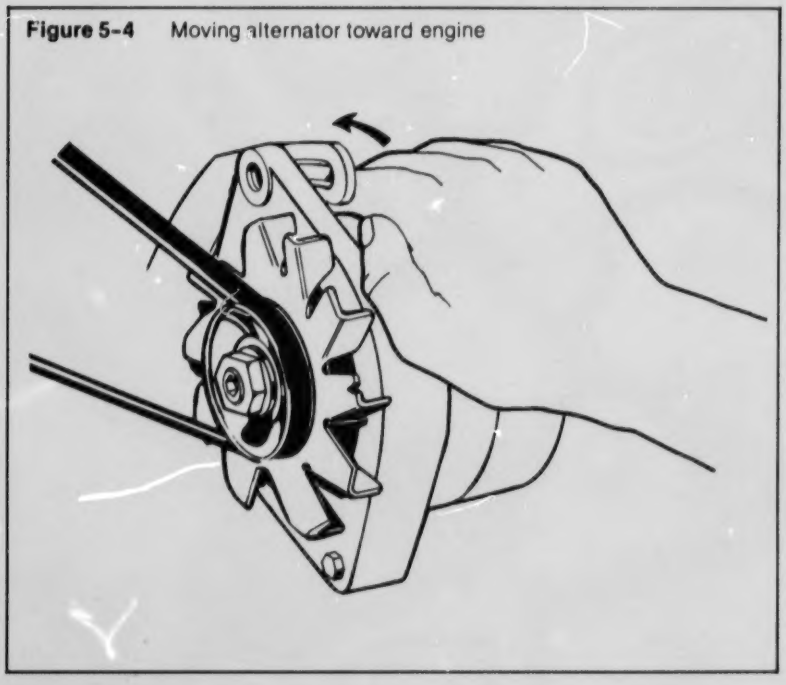
STEP 1 Loosen the alternator brace bolt and mounting bolt.

Figure 5-3 Loosening the alternator brace bolt and mounting bolt



STEP 2 Pivot the alternator toward the engine.

Figure 5-4 Moving alternator toward engine



STEP 3 Remove the belt from the alternator and crankshaft pulleys.

Figure 5-5 Alternator belt over pulleys

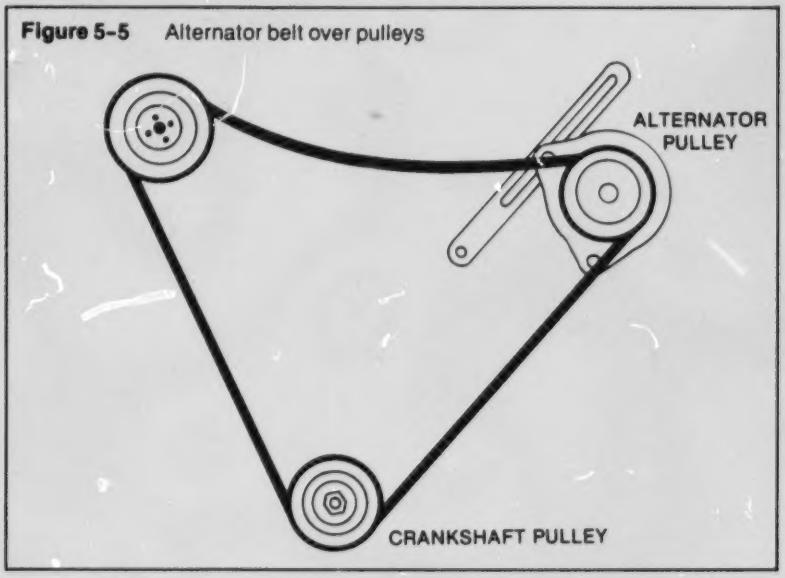
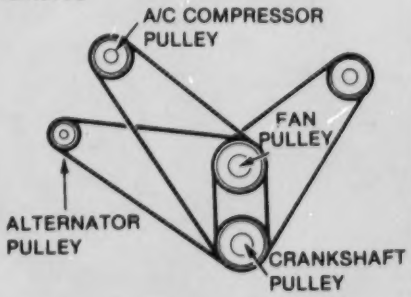


Figure 5-6 Belt systems requiring removal before alternator belt can be removed



NOTE: At this point there will be enough slack in the belt to easily remove it from the alternator and crankshaft pulleys.

STEP 4 Work the belt forward over the fan blades and withdraw the belt from the fan area.

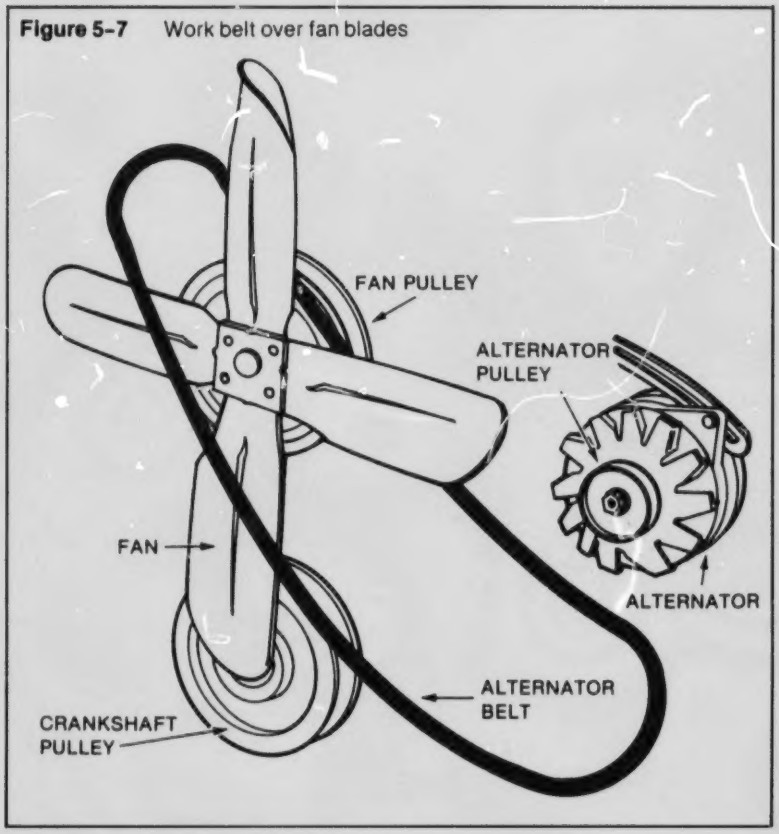
NOTE: Some models require that you remove other drive belts before you can remove the alternator belt, as shown in figure 5-6. Refer to the vehicle manufacturer's service manual if you can't follow these procedures for the car you're working on.

Installing the Alternator Belt

Use the alternator belt made for the type of vehicle you're working on.

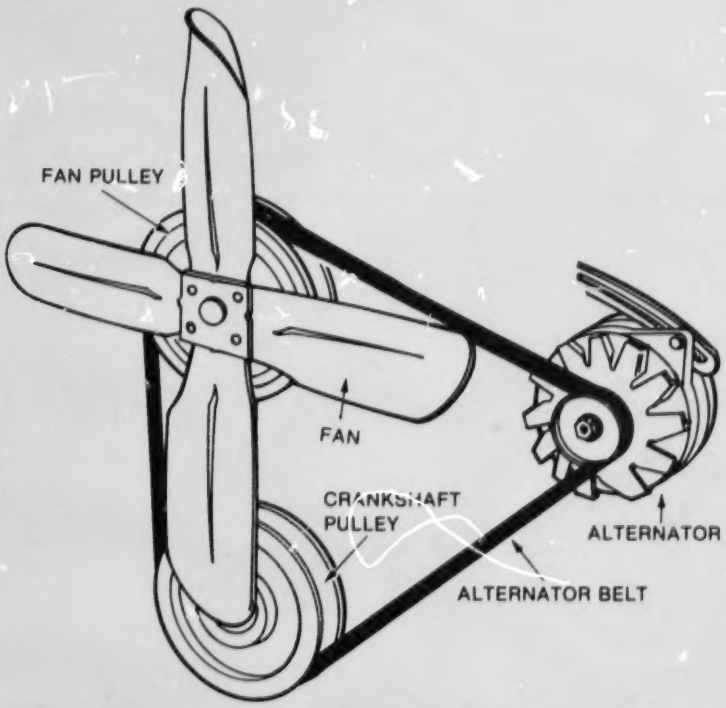
STEP 1 Work the belt over the fan blades from front to rear.

Figure 5-7 Work belt over fan blades



STEP 2 Fit the belt in the fan pulley, crankshaft pulley, and alternator pulley.

Figure 5-8 Fit the belt over the pulleys



Adjusting the Alternator Belt Tension

STEP 1 Refer to a technical service manual for belt tension specifications. The specifications will look something like those in table 5-1.

TABLE 5-1

BELT ADJUSTMENT
Measured with strand tension gauge (lbs.)

BELT	NEW	USED
Fan and alternator	110-140	70-75[1]
Power steering	135-165	100-105
Air conditioning	135-165	100-105
Air pump	110-140	70-90

[1]With 80 amp alternator, 135-165 (new); 100-105 (used).

To read the table, look under the *NEW* column if you will be adjusting a new belt. Look under the *USED* column for a used belt. Notice that the tension should be between 110 and 140 psi (pounds per square inch) for a new belt. It should be between 70 and 75 psi for a used belt. The specifications, however, refer only to a belt for a standard (about 42 amps) alternator.

The footnote on the chart lists separate specifications for an 80 amp alternator. Notice that the tension should be between 135 and 165 psi for a new belt on this type of alternator and between 100 and 105 psi for a used belt.

NOTE: Always use a tension gauge to check and adjust the alternator belt. The alternator belt should be checked from time to time to maintain the proper tension. ***Remember, a faulty belt can cause the engine to overheat and the battery to discharge!***

STEP 2 Position the tension gauge on the belt, halfway between the alternator pulley and the fan pulley.

Figure 5-9 Correct position for belt tension gauge

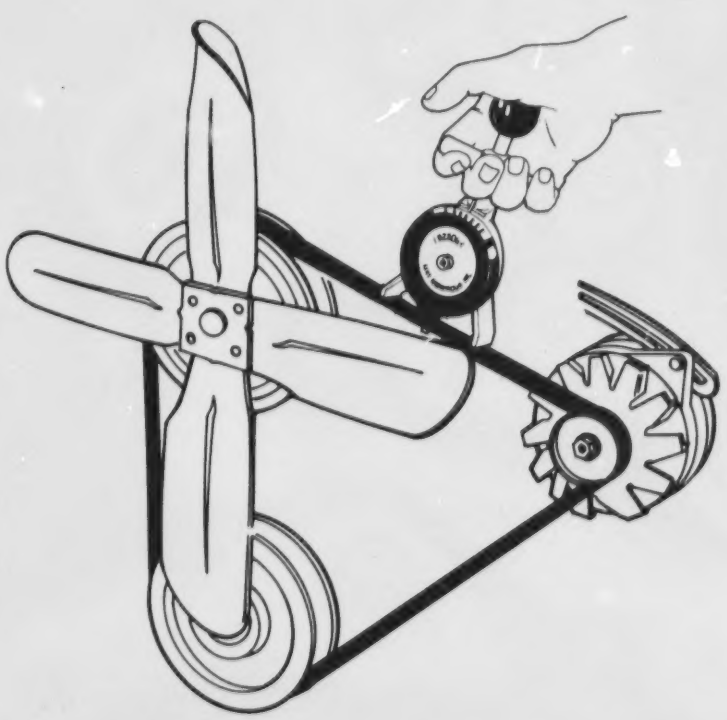
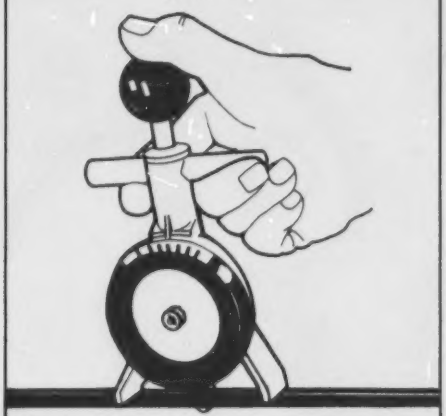


Figure 5-10 Press tension gauge plunger down



The best method of checking belt tension is to use a strand tension gauge. Tension gauges differ in design from one manufacturer to another, but all are used in a similar way. The hand-used tool has a hook that slides under the alternator belt. When you check the tension, be sure to do the following:

- Press the plunger down with your hand to place the hook under the belt.
- After the hook is under the belt, release the plunger.
- Check the dial indicator for the tension in the belt. The hook is attached to a spring-loaded plunger and a dial indicator. The indicator tells you how tight the belt is by measuring foot-pounds of pressure.
- Adjust the belt to the manufacturer's specifications.

NOTE: When testing notched belts, make certain the belt hook is placed in the notch, as in figure 5-12.

Figure 5-11 Check the dial indicator

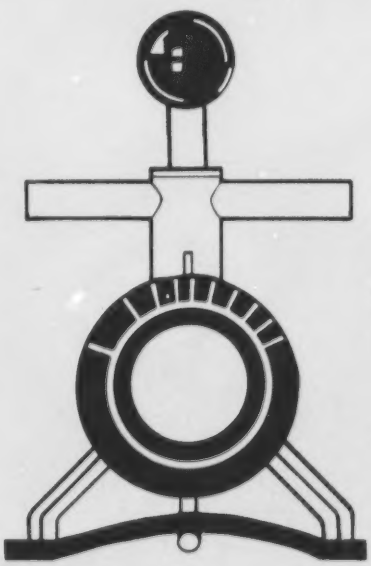
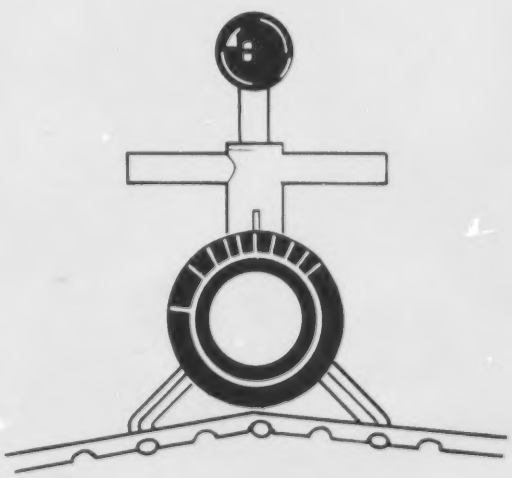


Figure 5-12 Correct position for testing notched belts



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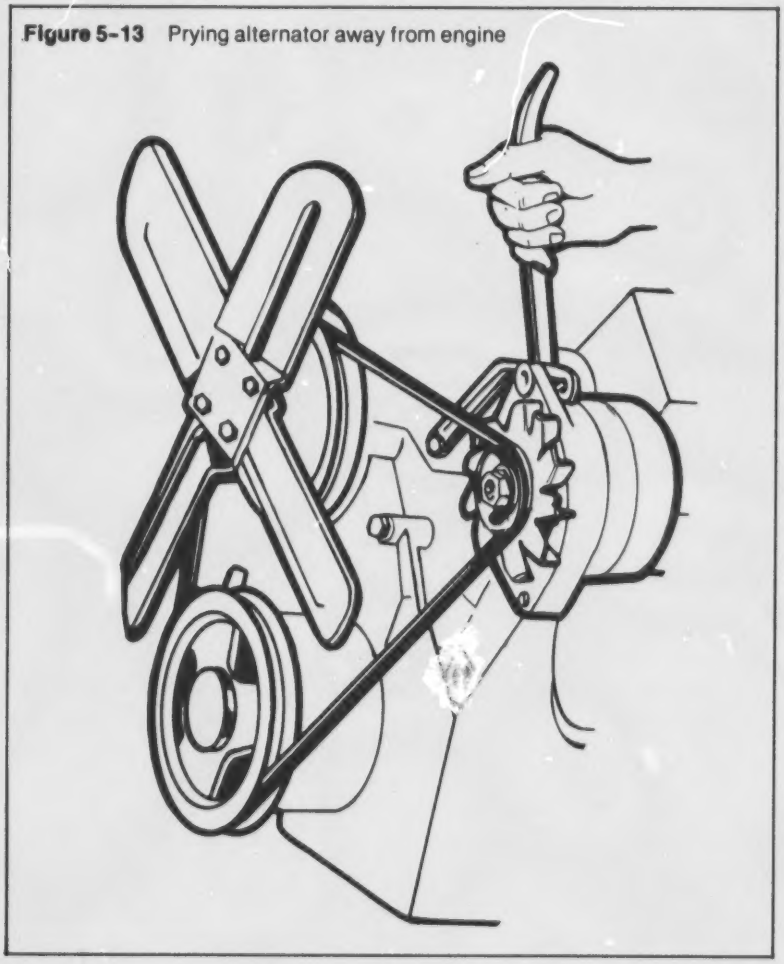
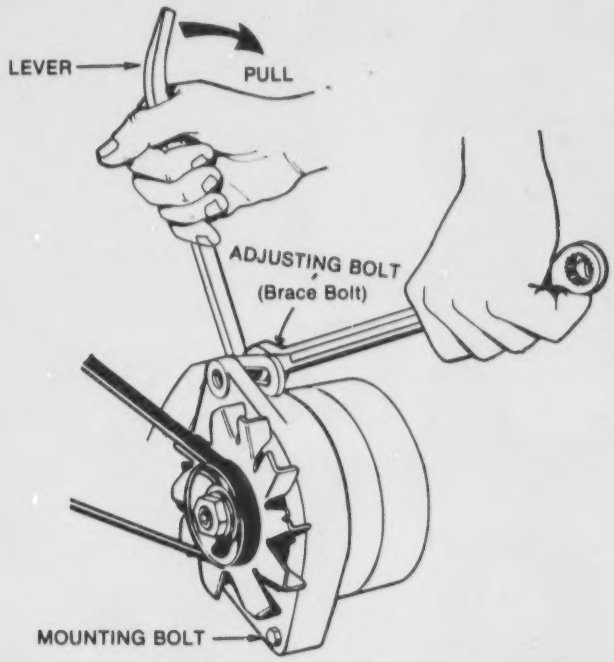
STEP 3 Using a suitable tool or lever, pivot the alternator away from the engine until the proper tension is indicated.

Figure 5-13 Prying alternator away from engine



STEP 4 Hold this position of the alternator and the tension of the belt, and tighten the alternator brace bolt.

Figure 5-14 Prying alternator while tightening the alternator brace bolt



STEP 5 Tighten the alternator mounting bolt (see figure 5-14).

STEP 6 Recheck the belt tension gauge. If the reading is not within specifications, loosen the mounting bolt and adjusting bolt, and readjust the belt tension.

STEP 7 Remove the belt tension gauge.

Turn to your Review Exercise Book and complete Exercise 2.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you are not sure that you can do a work activity, ask your instructor for help.

1. Inspect the alternator belt in a vehicle and list all visible defects. (page 14)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

2. Remove the alternator belt from a vehicle. (pages 15-16)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

3. Install the alternator belt. (pages 17-18)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

4. Adjust the alternator belt tension. (pages 18-22)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

When you have finished these activities, check with your instructor. Your instructor will tell you whether you are ready to be checked off on the performance checklist. If so, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 6

EVALUATE ALTERNATOR AND REGULATOR OUTPUT

INTRODUCTION TO P.O. 6

In this section, you'll learn how to evaluate alternator and regulator output. You may find it helpful to review Performance Objective 1 and Performance Objective 5. You'll find information on battery services and adjusting or replacing alternator belts, respectively.

After you have finished all the work activities for Performance Objective 6, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 6

The instructor will provide a vehicle on which the student can test the charging system. All necessary tools, equipment, and manuals must be made available.

Student Performance	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Checks the battery first.			
2. Performs the charging system output test and records the results.			
3. Performs the alternator output test and records the results.			
4. Performs the voltage regulator test and records the results.			
5. Performs the circuit resistance test and records the results.			
6. Performs the insulated circuit resistance test and records the results.			
7. Performs the ground circuit resistance test and records the results.			
8. Compares the test results to the manufacturer's specifications and reports any defective components.			
9. Uses proper tools and equipment.			
10. Follows all safety precautions.			
11. Time.			

SAMPLE

Tools and Equipment

You will need to use the following tools and equipment when you do the work activities for Performance Objective 6. You should already be able to use a basic hand tool set, so no procedures are provided here. The procedures for using special tools and equipment, however, will be provided as you work through the activities in this Student Guide.

Basic Hand Tool Set

Special-Purpose Hand Tools

battery pliers

Basic Equipment

voltmeter
ammeter
fender covers
extension light

Safety Equipment

eye protection

Special Equipment

starting/charging system tester

Reading List

The Student Guide has been carefully designed to provide you with only the information you need to know to complete each performance objective. If you would like additional information, however, you may wish to use the references below.

General References

Crouse, William H. ***The Auto Book.*** New York: McGraw-Hill, Inc., 1974, pp. 56–257.

Crouse, William H. ***Automotive Mechanics.*** 7th ed. New York: McGraw-Hill, Inc., 1975, pp. 240–295.

Ellinger, Herbert E. ***Automechanics.*** 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1977, pp. 246–270.

Stockel, Martin W. ***Auto Mechanics Fundamentals.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1974, pp. 385–391.

Stockel, Martin W. ***Auto Service and Repair.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975,

pp. (22–23) - (22–41).

Toboldt, William K. and Johnson, Larry. ***Automotive Encyclopedia.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975, pp. 353–380.

Special-Purpose Reference

Crouse, William H. ***Automotive Electrical Equipment.*** 8th ed. New York: McGraw-Hill, Inc., 1976, pp. 122-126.

Personal and Service Safety Practices

Safety When Working around an Operating Engine

- Do not reach into the engine without first looking. Your fingers could get caught in the moving parts. Serious injury may result.
- Always use fender covers when you work under the hood. This prevents scratches on the finish of the fenders from tools and equipment.
- Be careful to keep the extension light cord and testing equipment leads clear from belts, pulleys, and fan blades. Damage to the electrical leads or to the testing equipment may result.

Safety When Making Electrical Tests

- Follow the procedures described by the manufacturer of the electrical test equipment. This includes the proper care and use of the equipment, as well as calibrating the equipment correctly when you first start to use it.
- Never do any electrical tests while standing in water or if the vehicle or engine parts are wet. A painful shock may result.
- Never connect the volt-amp tester in the charging circuit while the engine is operating. Damage to the meters of your testing equipment may result.

Safety in Work Clothing and Grooming

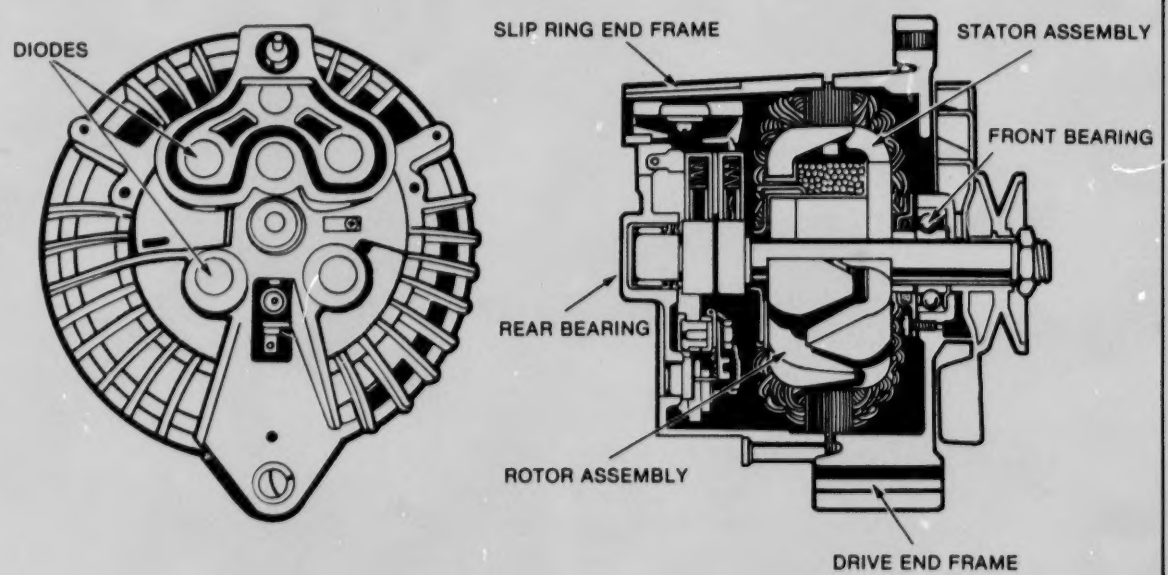
- Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that may come in contact with electricity. You can receive a severe burn if the metal you are wearing touches an electrical part.
- Avoid wearing loose clothing or anything that can hang down and get caught in the moving parts of an operating engine. Injury can result. Loose clothing can also catch on engine parts and tear.

- Keep hair away from moving parts. Keep your hair under a hat if it is longer than conventional length (reaches over your shirt collar).

The Alternator

The alternator is a device that produces alternating current (AC). The alternator rotates a magnetic field (the rotor assembly) between stationary conductors (the stator assembly). This process generates electrical current for electrical components in the vehicle.

Figure 6-1 Alternator: rear view and cutaway side view

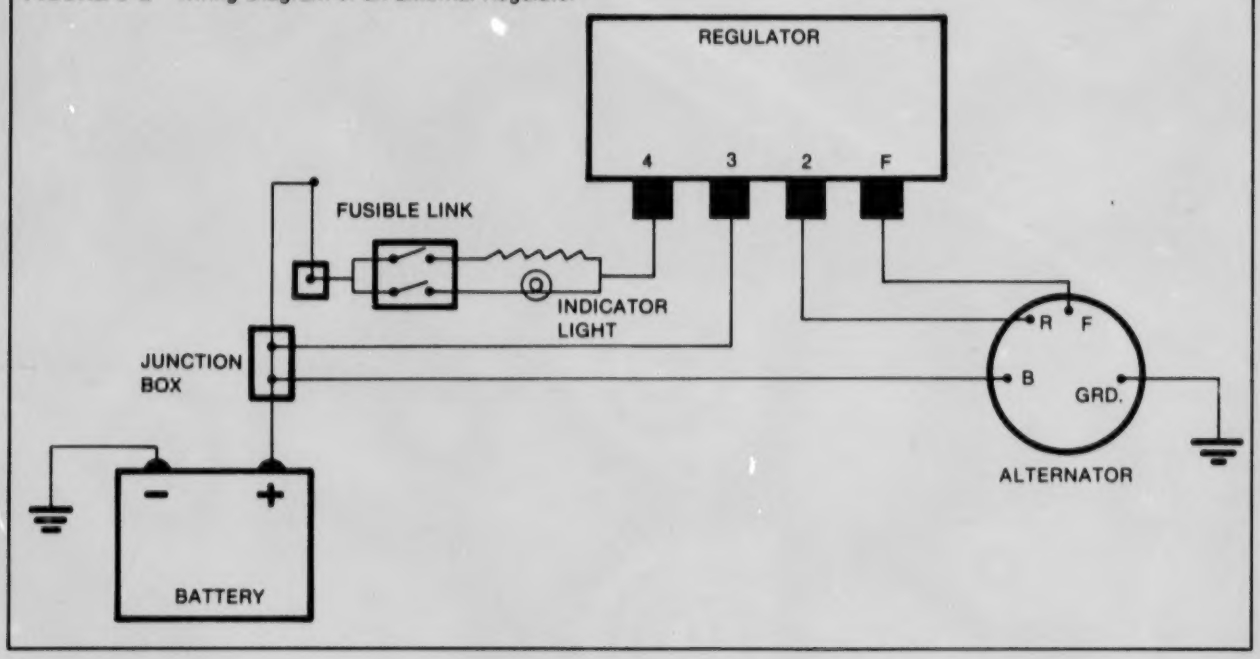


However, the alternator produces AC, which can't be used by the vehicle's other electrical components. For that reason, the AC output must be rectified, or changed to direct current (DC). This change is performed by devices called ***diode rectifiers*** or ***diodes.*** A diode is an electronic device that lets current flow through it in only one direction (see figure 6-1). For more detailed information on the internal components of the alternator, refer to ***Electrical Systems Service,*** another course in the Automotive Mechanics Curriculum.

External Alternator Regulator

The alternator must use a regulator to limit its output of current. There are two basic types of alternator regulators. One type is the ***external (outside) regulator.*** As you can see in figure 6–2, the external regulator is located apart from the alternator and is connected to other electrical components in the vehicle. The regulator has four terminals marked *F*, 2, 3, and 4. The *F* terminal is connected to the field terminal on the alternator. This connection is called the ***field relay.***

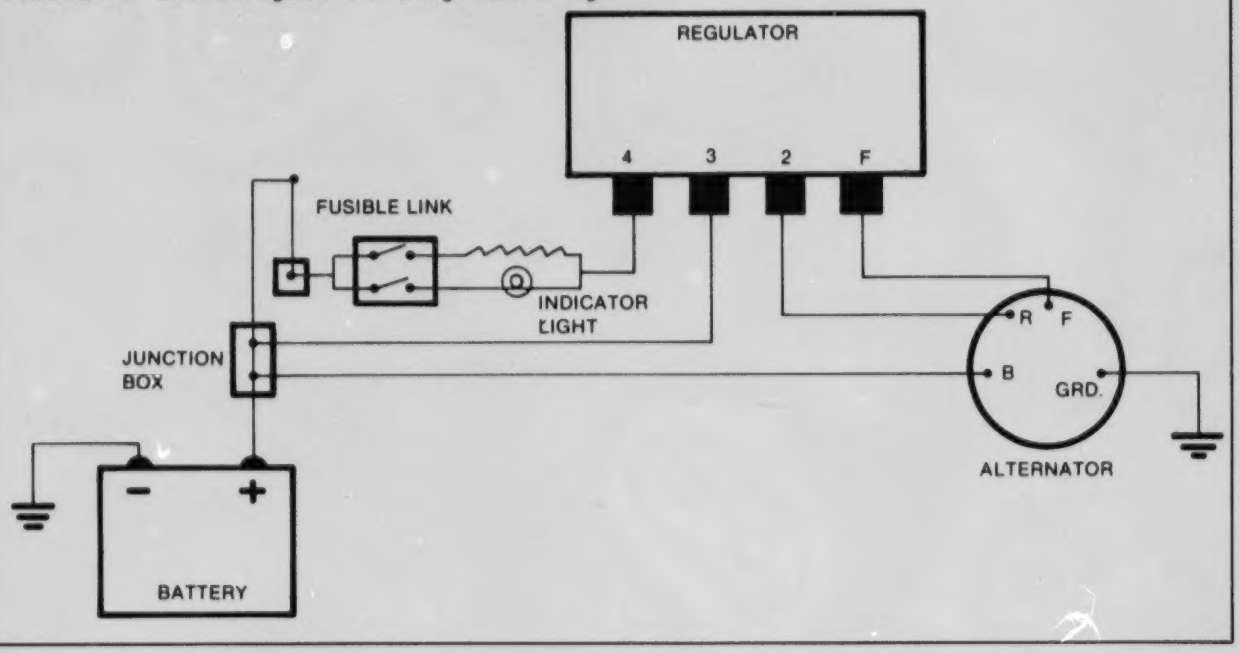
FIGURE 6–2 Wiring Diagram of an External Regulator



The field relay connects the alternator to the battery. This connection enables the battery to supply the alternator with current and thereby start the engine. The field relay also disconnects the rotor (in the alternator) from the battery. By doing so, the field relay prevents the battery from discharging through the rotor.

The voltage limiter is a part inside the regulator. Its purpose is to prevent the alternator and regulator circuits from overcharging at high and medium driving speeds. This part of the regulator is not adjustable. If it does not work properly, the entire regulator should be replaced.

FIGURE 6-3 External Regulator with Charge Indicator Light



The field relay may use a charge indicator light to show when the alternator is charging the battery. This light comes on when the ignition switch is turned on and the engine is cranking.

You'll notice in figure 6–3 that a resistor is placed in parallel across the indicator light. The resistor reduces any surge of voltage during cranking that could burn out the indicator light. If the light burns out, you should not only replace the light bulb, but also check the resistor. It may be burned out or broken.

When the engine is running, the light will go ***off*** if the alternator is charging the battery. If the light stays ***on*** when the engine is running, there is usually something wrong with the charging system. However, a blown fuse in the charge indicator light circuit may cause the light to be off while the engine is running. To find out whether a blown fuse is the problem, turn the engine off. Then turn the ignition switch to the "run" position and check the oil pressure light and the charge indicator light. If both lights are off with the ignition switch in the "run" position, the fuse is blown.

A fusible link or overload fuse is also placed into the charging circuit on some vehicle systems. It serves as a safety valve. If a short develops in the charging system and causes an excessively high charging rate, it will "blow" the fusible link. This will make the charging system inoperative. When the charging system doesn't work on a vehicle, first

check the fusible link to see whether it is burned out before doing other tests (see figure 6–3).

Some field relays use an ammeter instead of a charge indicator light. The ammeter measures the rate of current flow in amperes. Current from the alternator flows through the ammeter when the engine is running. The ammeter shows when the battery is being charged and indicates its rate of charge (see figure 6–4).

FIGURE 6–4 Wiring Diagram of a Charging System with an Ammeter

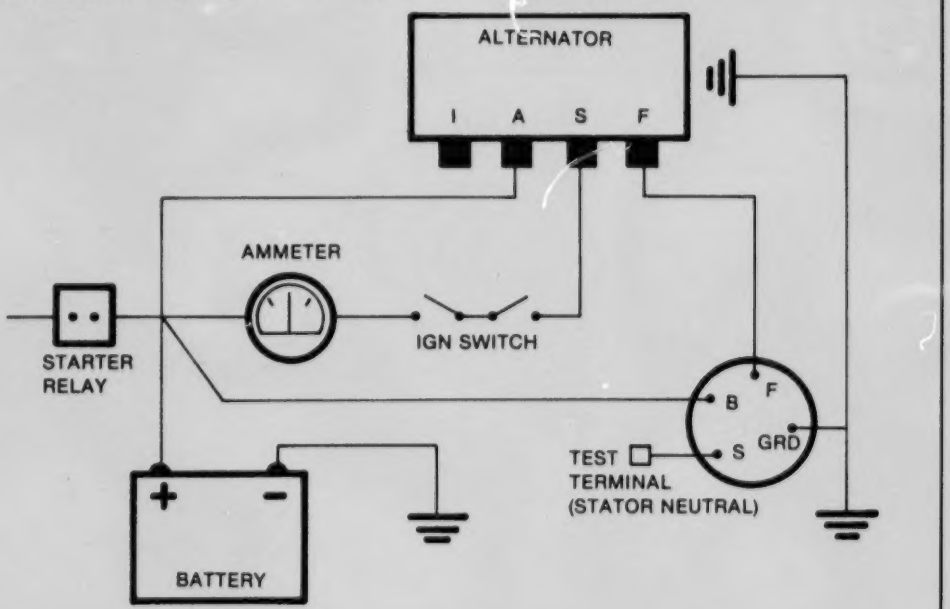
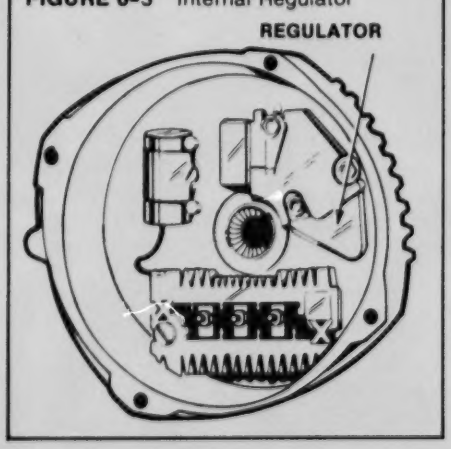


FIGURE 6–5 Internal Regulator



Internal Alternator Regulator

The internal or integrated regulator is built into the alternator. Like the external regulator, it regulates the field current to prevent too much alternator voltage from building up. The integrated regulator uses solid-state circuits and transistors. This means that if the regulator doesn't work properly, it must be replaced. It can't be repaired or adjusted.

Turn to your Review Exercise Book and complete Exercise 3.

Testing the Charging System

Visual Checks

You should always check first for visible defects in the charging circuit. Before you spend a lot of time testing the charging circuit, make these visual checks:

STEP 1 Check the battery. The battery must be fully charged before you check the other components of the charging system. Make sure that the battery terminals and clamps aren't corroded.

STEP 2 If the alternator belt is squealing, check for frays and cracks. Also make sure that the tension of the belt is correct.

STEP 3 Check all wiring connections to see whether they are tight and properly connected.

STEP 4 Examine wires for signs of wear, including burning or fraying.

STEP 5 Visually check the alternator and regulator for signs of damage.

STEP 6 Always make sure your test equipment is calibrated before you begin test procedures.

Noisy Alternator Checks

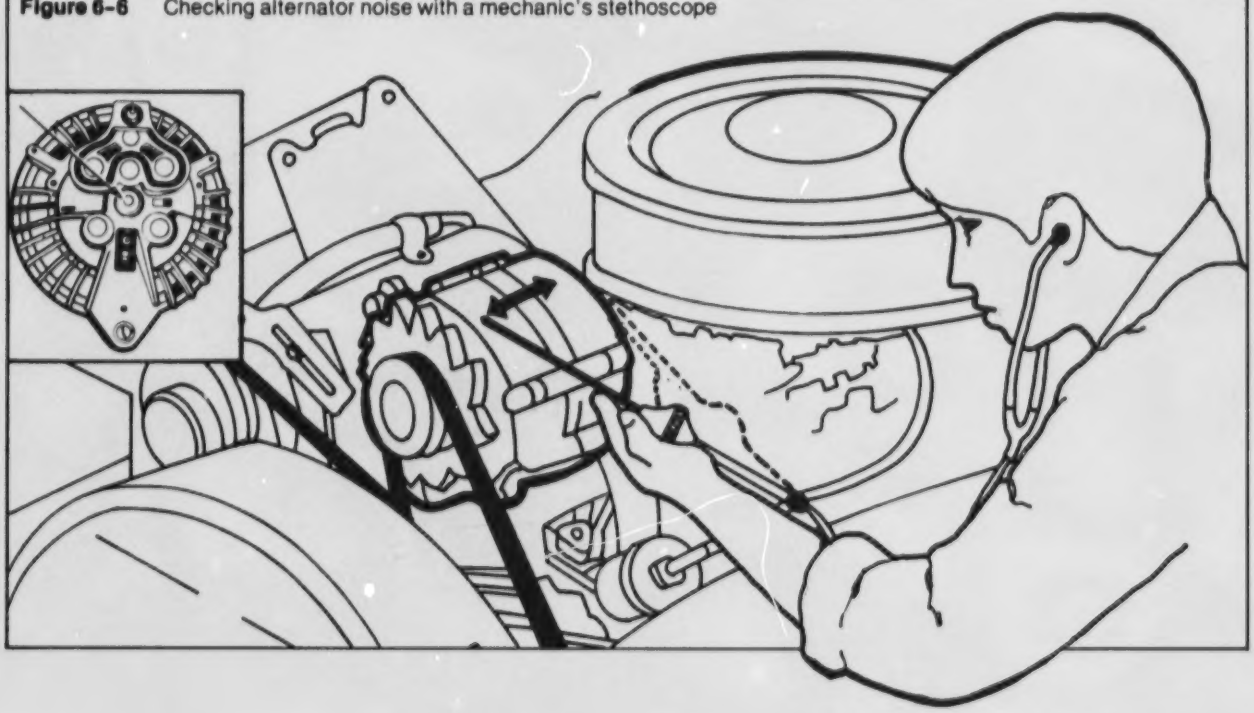
In addition to visual inspections, sometimes the alternator will be charging properly but will be noisy. You'll need to know how to check and locate noises coming from the alternator assembly.

STEP 1 Check the alternator belt for wear and looseness. Replace the belt if it is worn and/or adjust the belt tension if needed.

STEP 2 Check the alternator mounting to be sure it is tight. If it is loose, tighten the mounting bolt.

STEP 3 If the alternator assembly is still noisy, you'll need to check the alternator with a mechanic's stethoscope. Listening through the stethoscope will help you pinpoint where the noise is occurring.

Figure 6-6 Checking alternator noise with a mechanic's stethoscope



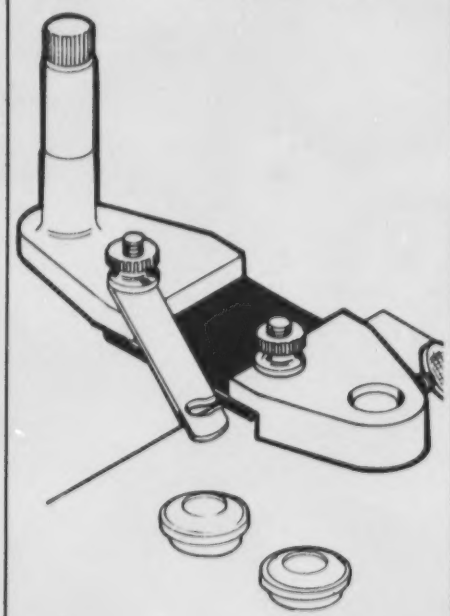
- With the engine operating, place the probe of the stethoscope on the front end frame of the alternator. Listen for any noises coming from the front bearing and pulley shaft of the alternator.
- Place the stethoscope probe on the rear frame of the alternator. Listen for any noises coming from the rear bearing and shaft of the alternator.
- If bearing noises are found, replace the alternator.

The Charging System Output Test

The charging system output test measures the amperage output of the charging system at a set voltage. The set voltage is normally 14 volts. (Remember, amperage is the amount of current flowing, and it is measured in amperes.) The output test tells you whether the charging system is producing the correct amount of amperes at a specified voltage.

To perform this test, you'll need a voltmeter, an ammeter, a carbon pile rheostat, and jumper wires. You may also need to use a piece of equipment called a ***battery post adapter.*** It's used to hook up test equipment to a battery post. You should use a volt-amp tester, which combines both a voltmeter and an ammeter. The ammeter part measures the amount of current flowing in the alternator. The voltmeter

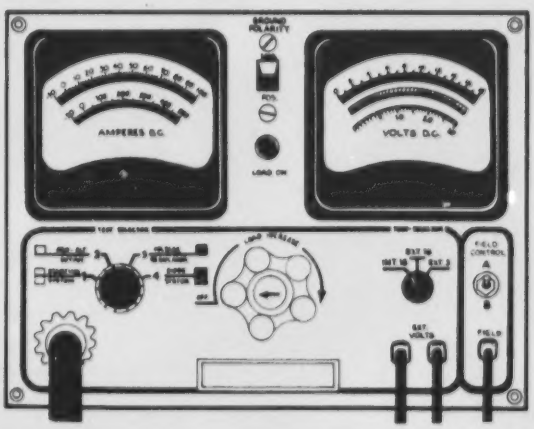
FIGURE 6-7 Battery Post Adapter



registers the number of volts produced by the charging system.

CAUTION: When you operate the alternator in this test, don't let the voltage exceed 16 volts. Excessive (too much) uncontrolled voltage can damage the electrical components in the vehicle. Likewise, do not let the voltage drop lower than 12 volts.

FIGURE 6-8 Volt-Amp Alternator Tester



Recent volt-amp testers use a clamp-around current probe that is recommended for use on electronic-type ignition systems. The clamp probe makes it unnecessary to break a circuit or use a battery post adapter.

NOTE—Direction of arrow pointing toward the battery positive and away from the battery negative.

Figure 6-9 Clamp around current probe on some volt-amp testers

Since there are several models of volt-amp testers used today, you'll have to follow the equipment manufacturer's instructions for the tester you are using. Also, refer to

the manufacturer's specifications for the type of charging system you are testing.

Find out what the vehicle manufacturer specifies as the proper rate of amperage output. The manufacturer's charging rate specifications will look something like those in table 6–1.

Table 6–1 1966–74 MOTORCRAFT (AUTOLITE) WITH SEPARATE REGULATOR

ALTERNATOR	*RPM*	*AMPS*
C5TF-G	2900	45
C5TF-H	2900	55

Table 6–1 states that for 1966–74 Motorcraft (autolite) charging systems having separate regulators, alternator No. C5TF-G at 2900 engine RPM (revolutions per minute) should have an output of 45 amps.

Here's another example:

TABLE 6–2 Delco Remy Delcotron Specifications

DELCO-REMY NUMBER	TEST SPECIFICATIONS (at 14.0 volts) AMPS	RPM	AMPS	RPM
1100927	22	2000	33	5000
1100928	30	2000	51	5000
1101016	50	2000	76	5000

The Delco Remy chart (table 6–2) states that for an alternator No. 1100927, the output amperage should be 22 amps at 2000 RPM with the voltage set to 14 volts. At 5000 RPM, the amperage output should be 33 amps.

Whenever you test charging systems, be sure that you have the correct alternator part number in order to find the correct charging amperage output specifications.

Then, perform the following steps to test the charging system output.

STEP 1 Connect the volt-amp tester to the charging system as specified by the equipment manufacturer.

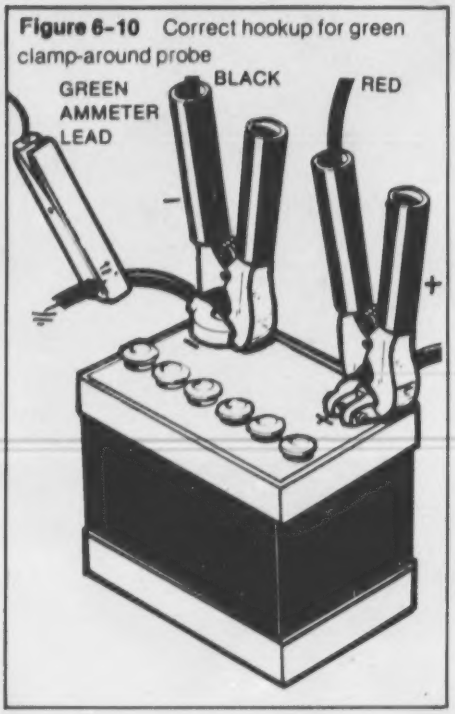


Figure 6–10 Correct hookup for green clamp-around probe

- When using the green clamp probe, attach it to the battery ground cable. Notice the direction of the arrow on the clamp. It should be pointing ***away*** from the battery negative.

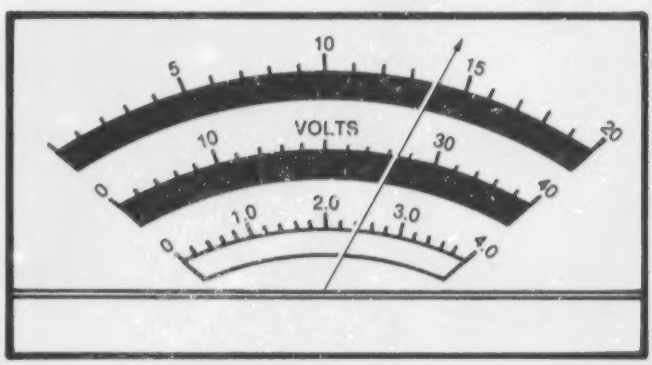
STEP 2 Turn the amp-selector switch to the 0–120 amps scale.

STEP 3 Connect a dwell/tachometer test instrument to the ignition system. The tachometer part of the instrument reads engine revolutions per minute (RPMs). To hook up the instrument, follow the equipment manufacturer's procedures.

STEP 4 Start the vehicle and operate it at the engine RPM specifications given by the vehicle manufacturer (generally, between 1500–2000 RPM).

STEP 5 Use the carbon pile rheostat or load increase control to hold the voltage to the amount specified by the vehicle manufacturer (usually 14 volts).

FIGURE 6–11 Voltmeter Scale

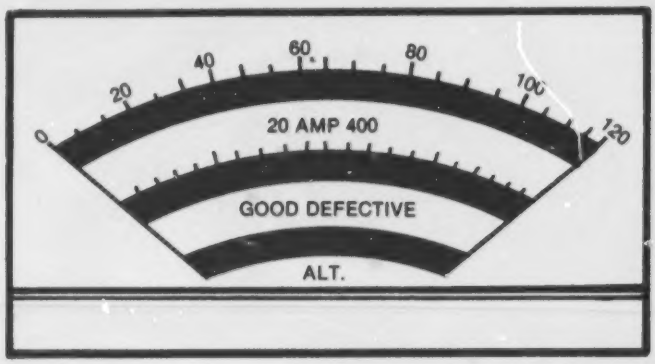


CAUTION: Do not let the voltage exceed 16 volts.

STEP 6 Read the highest reading on the ammeter scale.

41

Figure 6-12 Ammeter scale



The reading should equal the vehicle manufacturer's specifications. In this example, the ammeter reads 45 amps. Check your amperage output reading against the manufacturer's specifications.

GOOD The amperage reading is within 10 percent of the vehicle manufacturer's output specifications.

Using the above example, 10 percent of 45 amps is 4.5 amps. This means that, to be acceptable, your reading must be from 40.5 amps to 49.5 amps.

BAD The amperage output is not within 10 percent of the specifications.

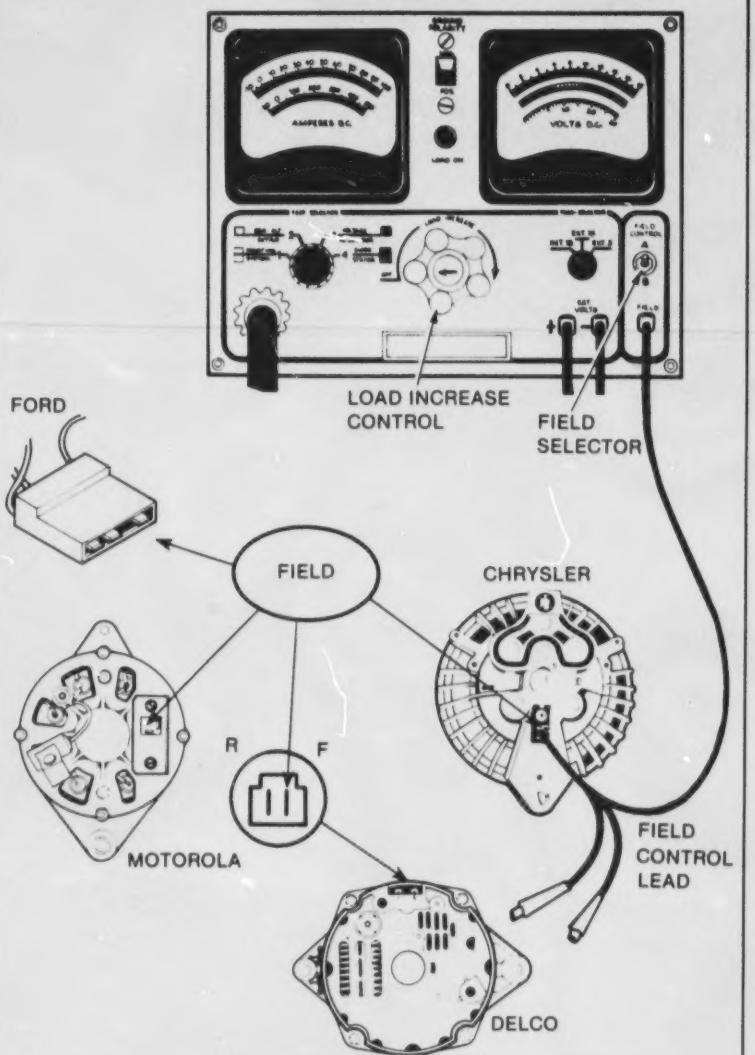
If your reading is 10 percent ***below*** the recommended output, go on and test the alternator to find whether the alternator or the regulator is at fault. (Read the information below about testing the alternator.)

If your reading for the output is 10 percent ***above*** the recommended output, go ahead and do a regulator test.

The Alternator Output Test

The alternator output is performed when the charging system has an ampere rating lower than the rated output. The alternator output test bypasses the regulator so that only the alternator output is checked. Remember, if the charging system output test results are 10 percent below the rated output, the alternator output test should be done.

Figure 6-13 Connections for alternator output test



Adapted from *Sun Volt Ampere Tester. Model VAT 28 Instruction Manual.* Used with permission of Sun Electric Corporation.

Follow the volt-amp tester manufacturer's directions to hook up the tester to the alternator. The field control lead of the tester has three connectors, and each one has a different design. Be sure to only use the ***one*** connector that best fits the field terminal on the alternator. Not all alternators are constructed alike, as you can see in figure 6-13.

STEP 1 Stop the engine. The ignition switch must be turned off.

STEP 2 Select the proper volt-amp field lead connection and attach it to the alternator field terminal. On some alternators, you

must disconnect the field wire at the alternator.

Be sure you know which alternator terminal is the field terminal. Refer to the technical service manual if in doubt.

STEP 3 Set the test selector on the 0–120 amps scale.

STEP 4 Start the engine and adjust the speed to the manufacturer's specified RPM as before (generally between 1500–2000 RPM).

STEP 5 Rotate the load increase control clockwise until the voltmeter reads approximately 2 volts less than the system's voltage.

CAUTION: Do not let the voltage exceed 16 volts.

STEP 6 Hold the field selector in the *B* position.

STEP 7 Read the highest reading on the ammeter scale.

GOOD The amperage reading is within 10 percent of the vehicle manufacturer's specifications. If the wiring is good, the voltage regulator is bad.

BAD The amperage reading does not reach manufacturer's specifications. The alternator is bad.

Alternator Output Test for Delcotron 10SI Integral Charging System (Solid State Internal Regulator)

STEP 1 Disconnect the battery ground cable and connect the volt-amp tester (Sun VAT 28 or an equal) as shown in figure 6-14.

STEP 2 Start the engine and set the engine speed between 1500–2000 RPM. Adjust the carbon pile to obtain maximum current output.

STEP 3 When maximum current output is obtained, insert the tip of a screwdriver into the end frame tab (figure 6–15). This will ground the field in the alternator.

FIGURE 6-14 Volt-Amp Tester Connections

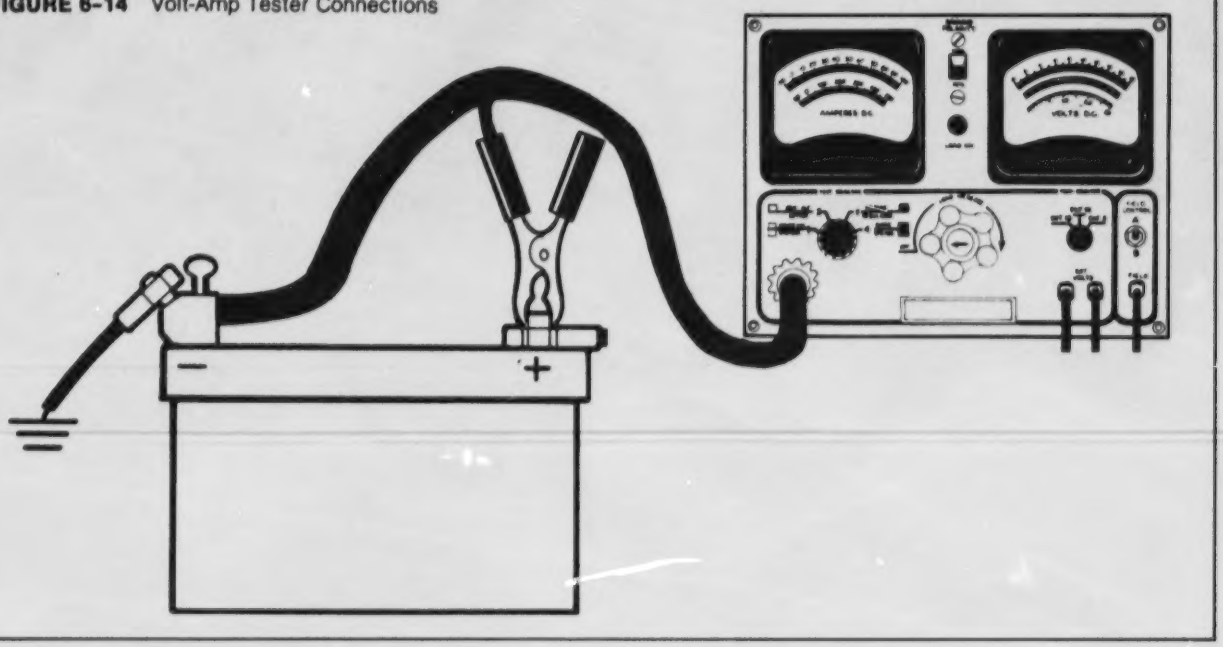
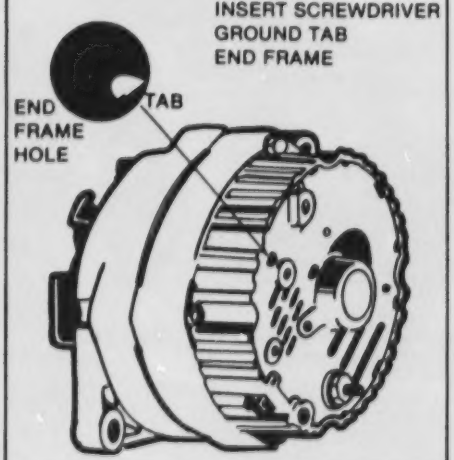


FIGURE 6-15 Delcotron Alternator (Internal with Regulator)



STEP 4 Check the volt-amp tester reading for total output of the alternator and compare it with the rated output.

RESULTS

- If the output is not within 10 amperes of rated output, the alternator is defective.
- If the output is within 10 amperes of rated output, the regulator is defective.

The Voltage Regulator Circuit Test

The voltage regulator circuit test tells you whether the voltage regulator is faulty. If the test shows voltages that are not within the range specified by the vehicle manufacturer, further testing is necessary to find the faulty component. The problem may be due to a bad regulator, improper wiring connections, or improper grounding of the regulator to the alternator.

Refer to the volt-amp tester directions that apply to the regulator. You are actually looking for the regulator setting that meets the vehicle manufacturer's specifications. If the nonadjustable regulators don't meet those specifications, they must be replaced. (Most vehicles made in the last few years have nonadjustable regulators.)

Before testing the output of the voltage regulator, look up the manufacturer's specifications in the technical ser-

vice manual. They will look something like table 6-3.

TABLE 6-3
Chrysler Corporation Double Contact
Voltage Setting (Lower Contact Test)

Ambient Temperature	Volts
47° F.	13.6—14.6
70° F.	13.5—14.5
93° F.	13.4—14.4
117° F.	13.3—14.3
140° F.	13.2—14.2
163° F.	13.1—14.1

NOTE: The ambient temperature is the temperature on an accurate thermometer positioned 1/4 inch from the regulator cover.

STEP 1 Set the test selector to the *REGULATOR* position. (The tester hookup is the same as for a charging system test.)

STEP 2 Operate the engine at a speed of 2000 RPM or at the speed specified by the vehicle manufacturer.

STEP 3 Note the reading on the voltmeter after it stops rising. (Generally, the charging rate is between 5 and 10 amperes.)

GOOD The voltage reading is within the manufacturer's specifications.

BAD The voltage reading is above or below the specified voltage range. The regulator must be replaced or adjusted.

Voltage Regulator Ground Circuit Resistance Test

The voltage regulator ground circuit resistance test is performed when you have isolated a problem in the charging system that is related to the regulator or to the charging system circuit resistance. If the charging system circuit resistance is within specifications, then the voltage regulator ground circuit resistance must be checked. This test will identify where there is corrosion or loose connections between the regulator and the battery ground post.

Before you make this test, be sure the voltage regulator is mounted tightly. Some external regulators have a ground wire attached from the mounting bolt to the firewall. Make sure this ground wire is tight. Also, check the battery ground post and the ground strap from the engine to the frame. After you look over these connections, refer to the test

equipment procedures for conducting the voltage regulator ground circuit resistance test.

STEP 1 Set the volt selector knob to *EXT 3 V* position.

STEP 2 Observing polarity, connect the test leads as shown to the regulator ground circuit (figure 6-16).

STEP 3 Start the engine and adjust the speed to approximately 2000 RPM.

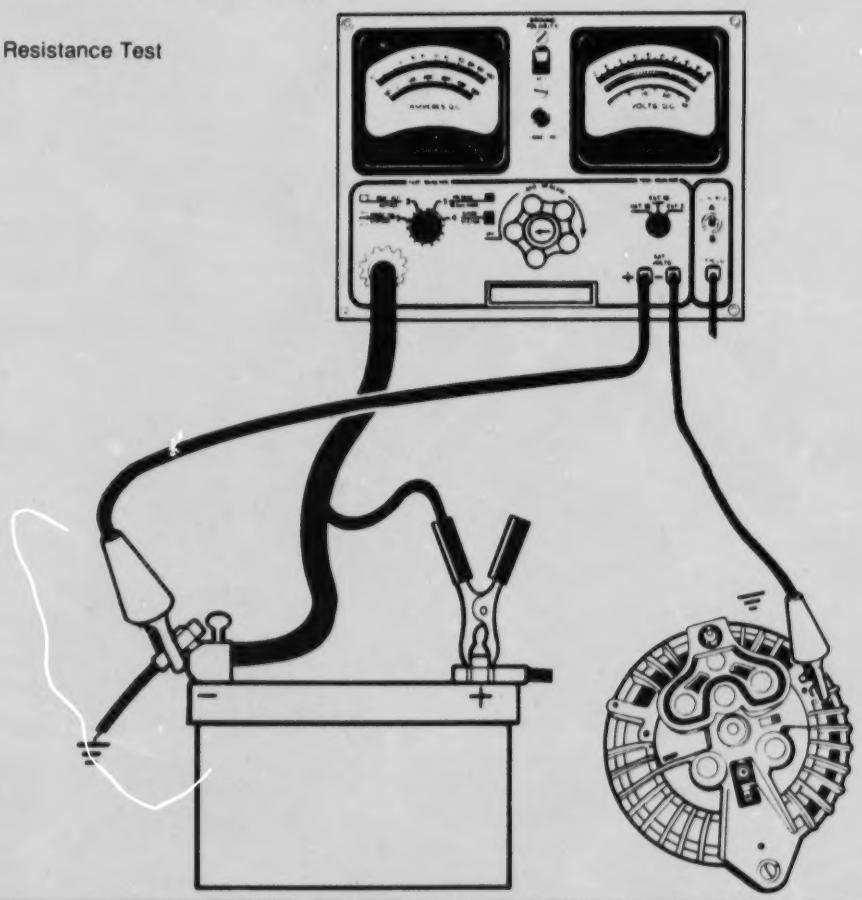
STEP 4 Adjust the load increase knob until the ammeter scale reads 10 amperes.

STEP 5 Look at the voltmeter scale and write down your reading.

RESULTS

If your reading is within specifications, the circuit is good and the regulator is defective.

FIGURE 6-16 External Voltmeter Lead Connections for Charging Regulator Ground Circuit Resistance Test



- If your reading is above specifications (more than 0.1 volt), excessive resistance is in the circuit between the regulator and the alternator. Check the regulator ground wire, mounting bolts, and ground strap for looseness or corrosion.

The System Circuit Resistance Test

The system circuit resistance test identifies voltage loss in two places: between the alternator output terminal and the insulated battery post, and between the alternator housing (case) and the ground battery post. Any voltage loss caused by high resistance in these circuits will reduce the overall charge rate and discharge the battery.

The system circuit resistance test is done following the volt-amp tester manufacturer's instructions. When you perform the circuit resistance test, you are testing the insulated circuit and the ground circuit at the same time.

If the resistance is higher than that specified by the vehicle manufacturer, perform the insulated test by itself. Then perform the ground test by itself, if necessary. This procedure will locate the faulty circuit. In other words, it will isolate the problem into one of the two circuits being tested. If the resistance is lower than the manufacturer's specification, the problem is not in the circuits you have just tested. Follow the volt-amp tester manufacturer's instructions for doing these tests.

STEP 1 Set the black test selector knob to the *GEN-ALT* position.

STEP 2 Turn the load increase knob to the *OFF* position.

STEP 3 Set the red volt selector knob to the *EXT 18 V* position.

STEP 4 Set the ground polarity switch to match the battery ground.

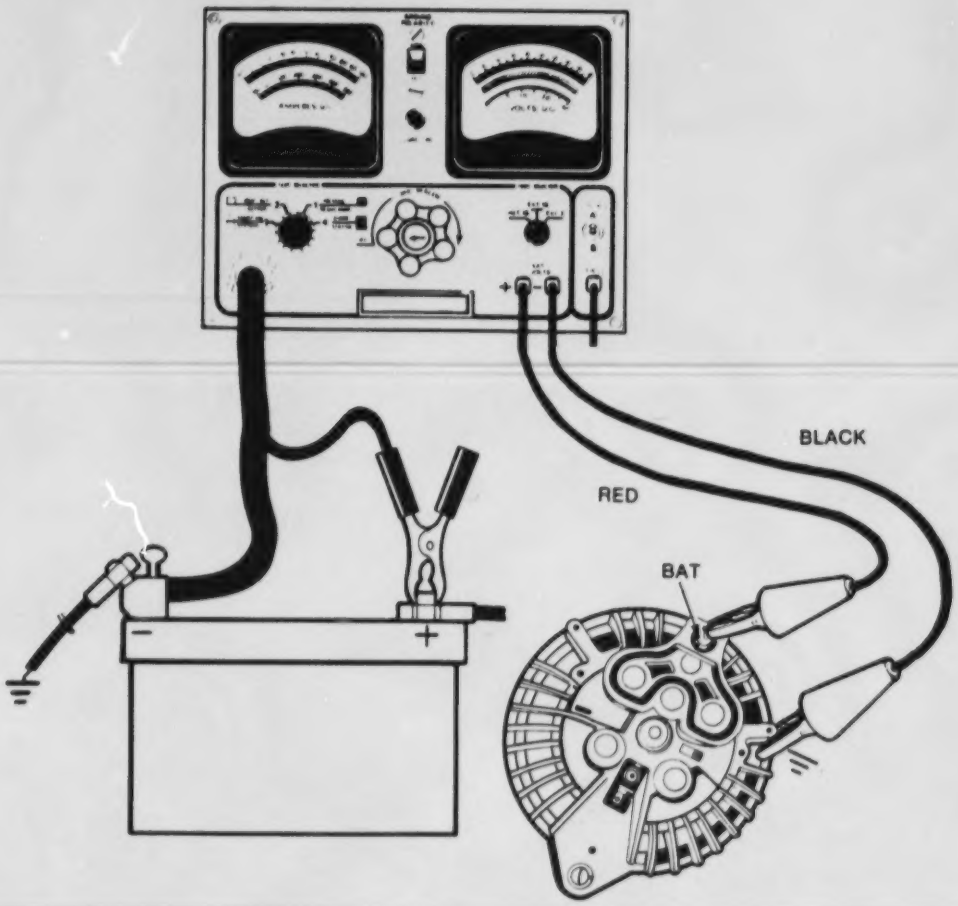
Figure 6–17 does not show the use of the clamp-around probe attached to the battery ground cable. However, use the probe if your volt-amp tester has one.

STEP 5 Connect the ext volt leads as shown above. (*EXT* stands for external leads.)

STEP 6 Start the engine and adjust the speed to approximately 2000 RPM.

STEP 7 Adjust the load increase knob until the reading of the ammeter scale shows 10 amperes.

Figure 6–17 Connections for system circuit resistance test



STEP 8 Note the reading on the voltmeter scale. Write down the reading.

STEP 9 Set the volt selector knob to the *INT 18 V* position. (This is a different position than in step 3. *INT* stands for internal leads connected to the load control.)

STEP 10 Write down the reading on the voltmeter scale. Subtract this reading from the reading obtained in step 8. The difference is the voltage drop caused by the charging circuit resistance.

In general, the circuit resistance specifications shown in table 6-4 apply to alternator systems.

TABLE 6-4 Circuit Resistance Specifications

TYPE OF VEHICLE	*VOLTS*
American Motors	0.65 volt max.
Chrysler Corp.	0.9 volt
Ford Motor Co.	0.4 volt w/indicator lamp
	0.8 volt w/ammeter
General Motors	0.65 volt

RESULTS

- If the voltage difference is within the specifications listed above, the charging circuit is good.
- If the voltage difference is higher than the specifications, a charging system insulated circuit resistance test should be conducted.

NOTE: The circuit resistance voltage reading (difference) is equal to the total of the insulated circuit and the ground circuit voltage losses.

The Insulated Circuit Resistance Test

The insulated circuit resistance test checks the circuit between the alternator output terminal and the insulated battery post. If you find that the voltage loss in the system circuit resistance test is higher than the specified amount, you know there is too much resistance in the charging circuit. There may be too much resistance in the terminal connections, the regulator, the ammeter, or the wiring between parts. Often this resistance is caused by loose or corroded connections. Check the following connections for looseness or corrosion:

- the output terminal of the alternator
- the back of the ammeter terminal (if equipped)
- the battery terminal of the solenoid battery cable connections
- the wiring from the ammeter to the solenoid

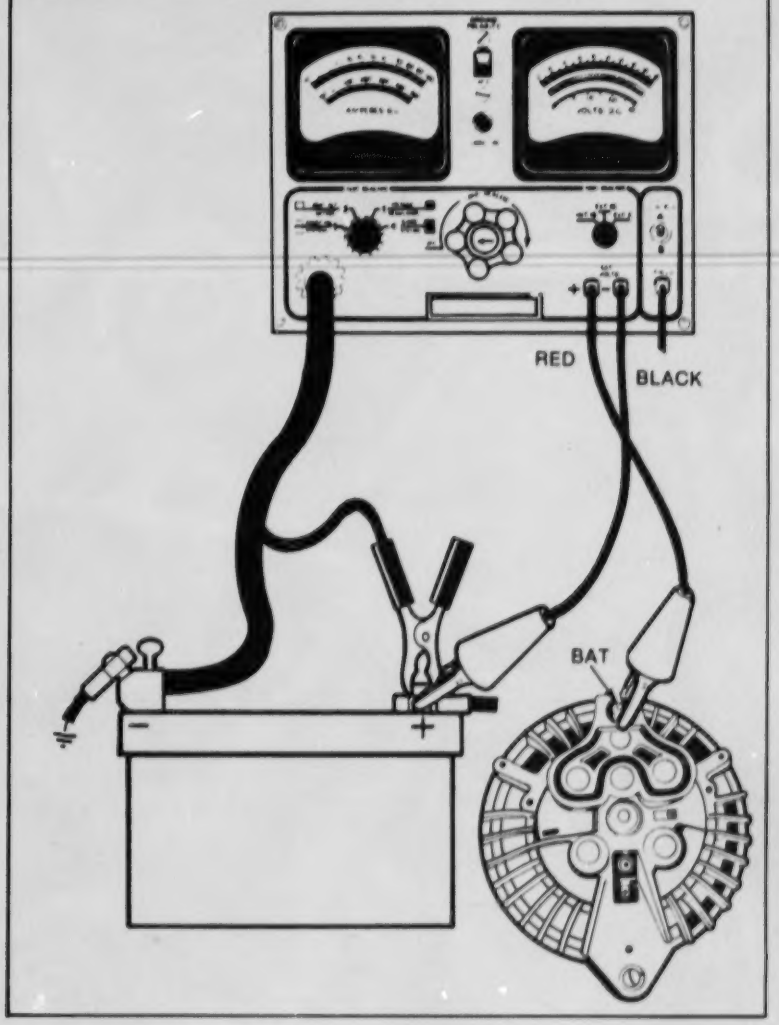
To test:

STEP 1 Set the volt selector knob to the *EXT 3 V* position.

STEP 2 Connect the tester leads as shown in figure 6-18.

- Note that the black voltmeter lead is now connected to the positive battery terminal. Use the clamp-around probe if your tester has one.

Figure 6-18 Connections for insulated circuit resistance test



STEP 3 Start the engine and adjust the speed to approximately 2000 RPM.

STEP 4 Adjust the load increase knob until the ammeter scale reads 10 amperes.

STEP 5 Look at the voltmeter scale and write down your reading. Compare your test readings against the circuit resistance test specifications. The maximum reading

should not be more than 0.8 volt.

RESULTS

- If voltmeter reading is not more than 0.8 volt, proceed to the ***ground circuit*** resistance test.
- If voltmeter reading is above 0.8 volt, there is too much circuit resistance. To find out where the problem is, repeat this test while connecting the voltmeter leads across each connection and each wire of the insulated circuit. This will pinpoint the wire or connection that is causing the problem.

The Ground Circuit Resistance Test

The ground circuit resistance test will identify where there is corrosion or a loose connection between the alternator housing (case) and the battery ground post. Before you make this test, look over these connections for signs of corrosion or loose connections.

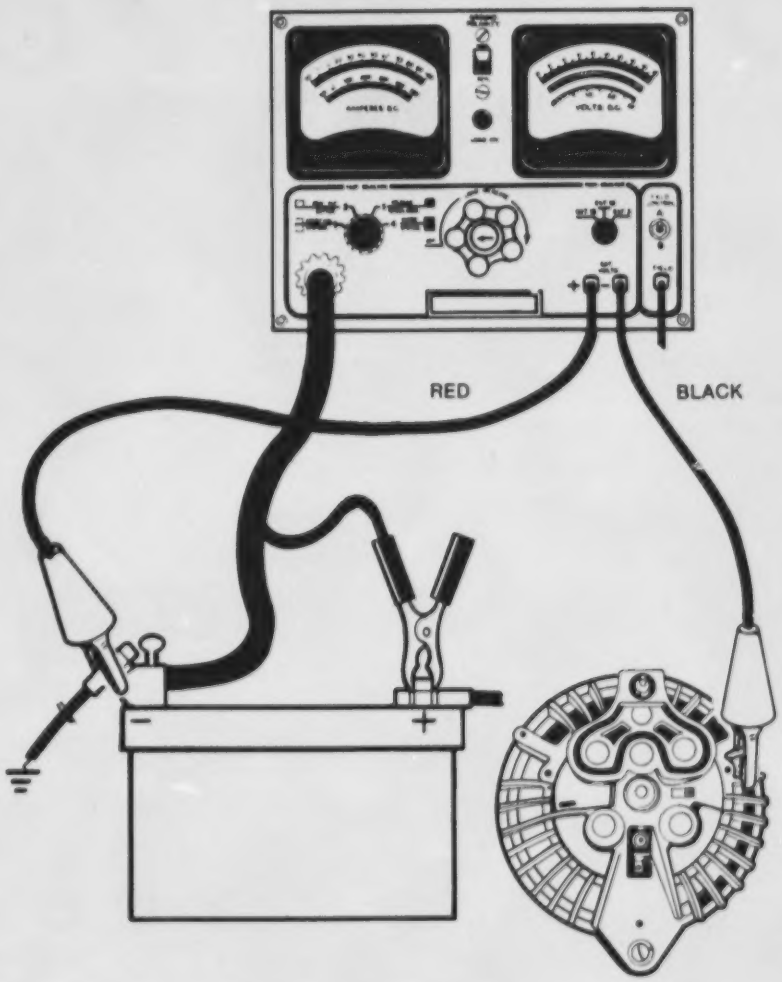
- Be sure the alternator mounting bolt or bolts are tight. These bolts are the ground connections for the alternator.
- Be sure the voltage regulator (external) is mounted tightly. The regulator is mounted with screws or bolts.
- Some regulators have a ground wire attached from the mounting bolt to the firewall. Be sure this ground wire is tight.
- Check the battery ground cable at the battery post and at its ground connection. (Remember, the ground connection can be either at the vehicle engine or frame.)
- Check the ground strap from the engine to the frame.

After you look over these components, refer to the test equipment procedures for conducting the ground circuit resistance test.

To test:

STEP 1 Connect the volt-amp tester leads, as shown below, to the ground circuit. Connect the black voltmeter lead to the alternator housing. Connect the red voltmeter lead to the battery negative (ground). Use the clamp-around probe if your tester has one.

Figure 6-19 Connections for ground circuit resistance test



STEP 2 Start the engine and adjust the speed to approximately 2000 RPM.

STEP 3 Adjust the load increase knob until the ammeter scale reads 10 amperes.

STEP 4 Look at the voltmeter scale and write down your reading. Compare your test readings against the circuit resistance test specifications.

RESULTS

- If the readings are within specifications, the ground circuit is good. Replace the voltage regulator.

- If the ground circuit shows high resistance, separate the ground component that has the high resistance. To do this, repeat the test while connecting the voltmeter leads across each connection and each wire of the ground circuit.

Turn to your Review Exercise Book and complete Exercise 4.

WORK ACTIVITIES

Before doing a work activity, make sure you've learned all the information that comes before it. If you need a review, read the information on the pages listed in parentheses next to each work activity. Do not begin any of these work activities until you have your instructor's approval. If you are not sure that you can do a work activity, ask your instructor for help.

1. Perform the charging system output test. (pages 34-39)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

2. Perform the alternator output test. (pages 39-42)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

3. Perform the voltage regulator circuit test. (pages 42-45)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

4. Perform the system circuit resistance test. (pages 45-51)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

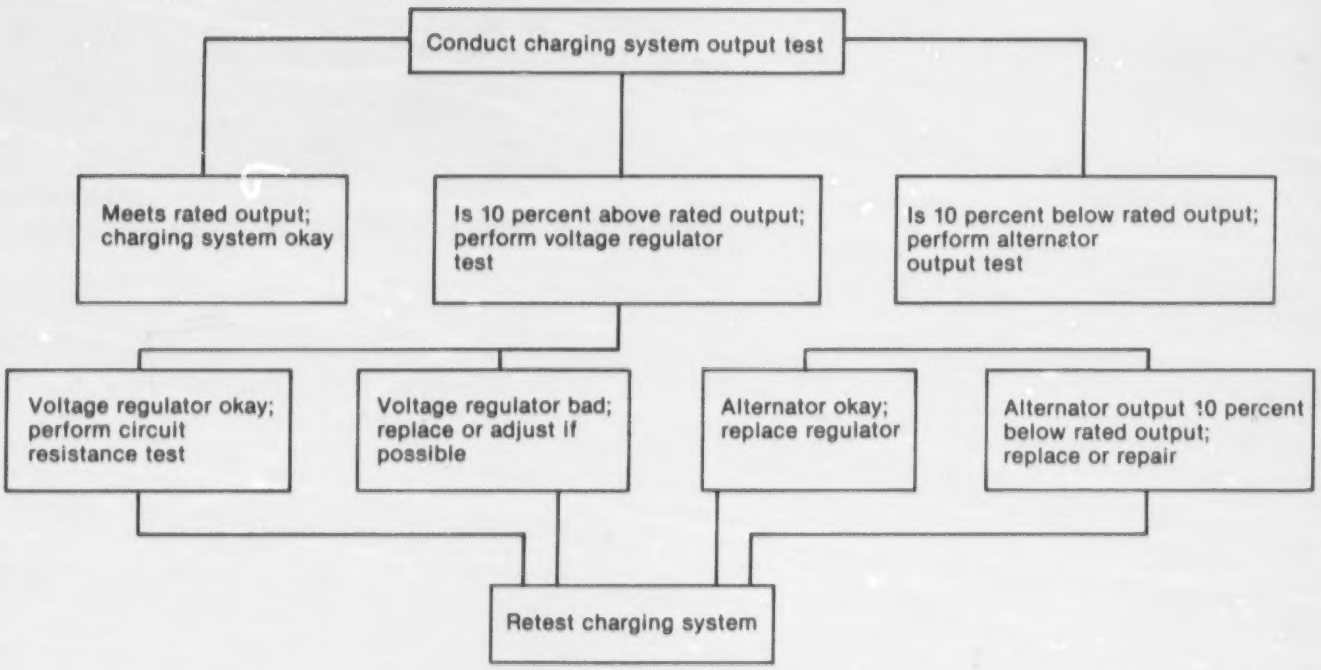
When you have completed these activities, check with your instructor. Your instructor will tell you whether you are ready to be checked off on the performance checklist. If so, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

The chart below shows you the tests you should perform to diagnose charging system problems. When you begin testing the charging system, refer to this chart for the proper procedures. There is also a flow chart in the appendix

that you should consult when diagnosing charging system problems. (Remember, the term *specifications* in these charts refers to the vehicle manufacturer's specifications for the type of system you are testing.)

Table 6-5 shows the sequence in which the charging system tests are performed. Study this chart until you can remember the proper sequence for the tests.

TABLE 6-5 Charging System Tests


Conduct charging system output test
Meets rated output; charging system okay
Is 10 percent above rated output; perform voltage regulator test
Is 10 percent below rated output; perform alternator output test
Voltage regulator okay; perform circuit resistance test
Voltage regulator bad; replace or adjust if possible
Alternator okay; replace regulator
Alternator output 10 percent below rated output; replace or repair
Retest charging system

Turn to your Review Exercise Book and complete Exercise 5.

PERFORMANCE OBJECTIVE 7

REMOVE AND INSTALL AN ALTERNATOR

INTRODUCTION TO P.O. 7

In this section, you'll learn how to remove and install an alternator. You may find it helpful to review Performance Objective 5, where you'll find information on adjusting or replacing alternator belts.

After you have completed the work activity for Performance Objective 7, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST — P.O. 7

The instructor will provide a vehicle on which the student can remove and replace the alternator. All necessary tools, equipment, and manuals must be made available.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Disconnects the ground cable clamp from the battery.			
2. Removes and marks the wires from the alternator.			
3. Removes the adjusting bolt, loosens the mounting bolt(s), and removes the belt.			
4. Removes the mounting bolt(s) and the alternator.			
5. Removes the pulley from the old alternator and installs it on a new alternator if necessary.			
6. Installs a new alternator and replaces the mounting bolt(s), belt, and adjusting bolt.			
7. Adjusts the alternator to provide proper belt tension and tightens the bolts.			
8. Checks the belt tension with a suitable gauge.			
9. Reconnects the wires to the alternator; reconnects the battery cable clamp.			
10. Makes the appropriate output check.			
11. Uses proper tools and equipment.			
12. Follows safety precautions.			
13. Time.			

SAMPLE

Tools and Equipment

You will need to use the following tools and equipment when you do the work activity for Performance Objective 7. You should already be able to use a basic hand tool set, so no procedures are provided here. The procedures for using special tools and equipment, however, will be provided as you work through the Student Guide.

Basic Hand Tool Set

Special-Purpose Hand Tools

20-inch pry bar
battery pliers

Basic Equipment
voltmeter
ammeter
fender covers
extension light
belt tension gauge

Safety Equipment
eye protection

Special Equipment
starting/charging system tester

Reading List

The Student Guide has been carefully designed to provide you with only the information you need to know to complete the performance objective. No additional text material is needed for this performance objective.

Personal and Service Safety Practices

Safety When Working Around an Alternator

- Always use fender covers when you work under the hood, since tools, equipment, and belt buckles can scratch the finish on the fenders.
- Remove the ignition key from the ignition switch. If someone started the engine accidentally while you were working with the alternator, severe personal injury could result.
- When adjusting alternator belts, always pry against the part of the alternator where the two halves join. This is the most solid part of the alternator and will avoid damaging or crushing it.
- Always adjust the alternator belt to the manufacturer's specifications, using a belt tension gauge. This will ensure correct belt tension for proper operation of the alternator.

Safety in Work Clothing and Grooming

- Avoid wearing loose clothing or anything that can hang down and get caught in the moving parts of an operating engine. Injury can result. Loose clothing can also catch on engine parts and tear.
- Keep hair away from the moving parts of an operating engine. Keep your hair under a hat if it is longer than conventional length (reaches over your shirt collar).

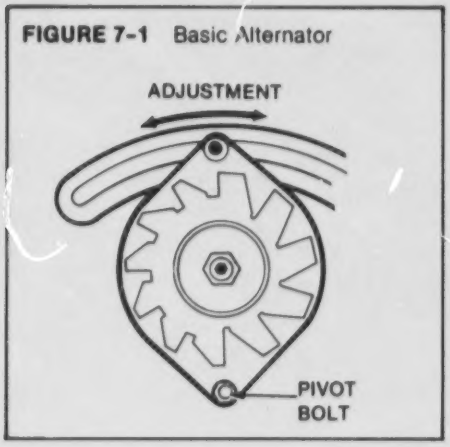


FIGURE 7-1 Basic Alternator

Removing and Installing an Alternator

Removing an Alternator

STEP 1 Disconnect the battery ground cable from the battery ground terminal.

STEP 2 Find the wire leads to the alternator and disconnect them from the alternator. Identify these wires by marking them where they originally attached.

STEP 3 Loosen and remove the alternator adjusting bolt.

STEP 4 Loosen the alternator pivot or mounting bolt.

STEP 5 Move the alternator toward the engine and remove the alternator belt from the alternator pulley (see figure 7–1).

STEP 6 Remove the alternator pivot or mounting bolt. Remove the alternator from the engine.

NOTE: Pay particular attention to the location of the alternator mounting and the mounting bolt. The old alternator housing and mounting locations should match those of the new alternator.

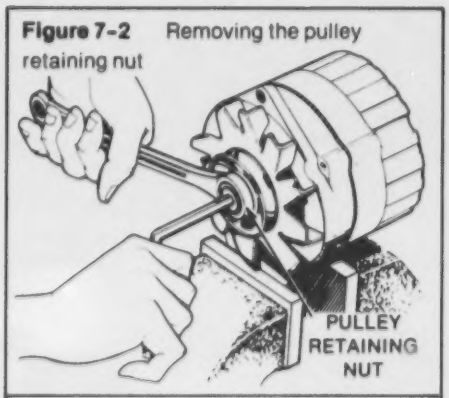


Figure 7-2 Removing the pulley retaining nut

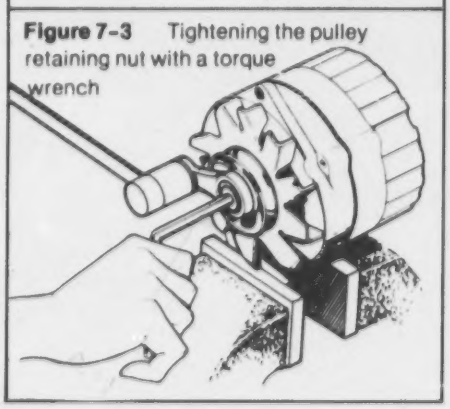


Figure 7-3 Tightening the pulley retaining nut with a torque wrench

Changing the Alternator Pulley

When replacing alternators, it is necessary in many cases to change the pulleys. Some new alternators are not furnished with pulleys. You'll find it necessary to remove the old pulley from the old alternator and install it on the new alternator.

STEP 1 Clamp the alternator in a vise, gripping the alternator mounting flange.

CAUTION: Do not grip the alternator in the vise in any other way. You could permanently damage the alternator.

STEP 2 Remove the pulley retaining nut. Some require the use of a box wrench and an allen wrench as illustrated in figure 7–2.

STEP 3 Remove the pulley from the alternator. Some pulleys simply slide off their shaft while others require the use of a puller. Be sure you follow the manufacturer's directions.

STEP 4 Install the pulley on the shaft of the new alternator. Tighten the pulley retaining nut according to the manufacturer's specifications.

Installing an Alternator

STEP 1 Place the alternator in position in the vehicle. Slide the pivot attaching bolt back in place.

STEP 2 Install the alternator belt over the alternator pulley. Check the alignment of the belt and the pulley to the water pump pulley and the crankshaft pulley.

NOTE: All pulleys must be properly aligned with each other. If not, the alternator belt will not last nearly as long as it could. Also, check to be sure all pulleys are of the same design so that the alternator belt fits into the pulleys as designed. If pulleys do not align, check with your instructor.

STEP 3 Put the alternator adjusting bolt back into the adjustment bracket.

STEP 4 Use the belt tension gauge to adjust the belt tension to the manufacturer's specifications. (Follow the directions contained in Performance Objective 5.)

STEP 5 To adjust, use a pry bar to pry the alternator away from the engine and tighten the adjusting bolt. Then tighten the pivot or mounting bolt.

CAUTION: Be sure to place the pry bar against that part of the alternator where the two halves join. This is the most solid part of the alternator.

STEP 6 Reconnect the wire leads to the alternator. Be sure they are connected to the correct terminals.

STEP 7 Reconnect the battery ground cable to the battery terminal.

STEP 8 Start the engine and perform a charging system output test. (Follow the directions contained in Performance Objective 6.)

Turn to your Review Exercise Book and complete Exercise 6.

WORK ACTIVITY

Before doing this work activity, make sure you've learned all the information that comes before it. If you need a review, read the information on the pages listed in parentheses next to the work activity. Do not begin the activity until you have your instructor's approval. If you're not sure that you can do the activity, ask your instructor for help.

Remove and install an alternator. (pages 58-59)

CHECK YOUR WORK WITH YOUR INSTRUCTOR

When you have finished this activity, ask your instructor to give you back your pretest for Unit 2. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will tell you whether you are ready to take the posttest or be checked off on the performance checklist, or whether you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

APPENDIX:

CHARGING SYSTEM GRAPHIC DIAGNOSIS CHART

APPENDIX: CHARGING SYSTEM GRAPHIC DIAGNOSIS CHART

The flow chart on the next few pages is your guide to diagnosing problems in the charging system. The chart will help you quickly find the cause of a problem.

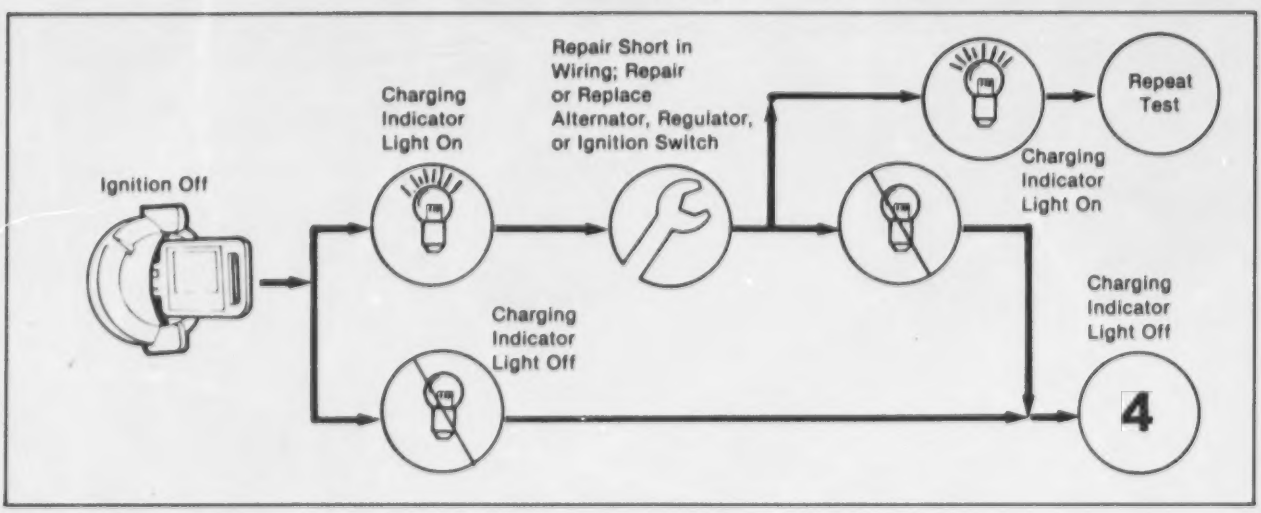
There are a number of symbols that you need to know before you can interpret the chart.

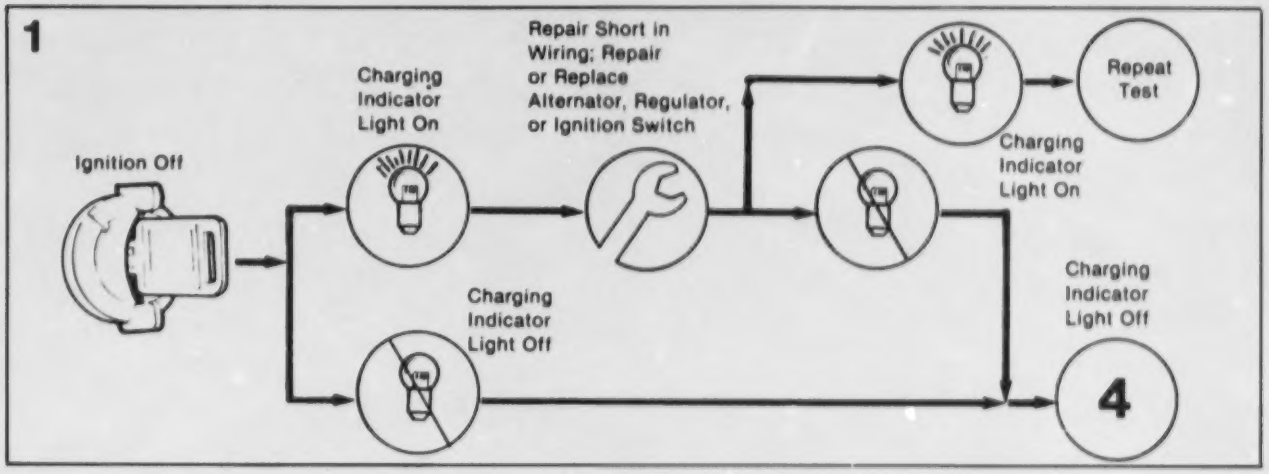
Symbol	*Meaning*
STOP	You have repaired the problem.
REPAIR	Repair to adjust the part.
OKAY	This part of the test works.
NOT OKAY	This part of the test doesn't work.
LIGHT ON	Current is flowing in this circuit.
LIGHT OFF	Current is not flowing in this circuit.

When using the troubleshooting chart, always start with the first step and follow each sequence from left to right. At the end of each sequence, there is a check to see whether the problem has been corrected. You are then told which step to take next. Continue working through each step until you have solved the problem.

If you can't find the cause of the problem, repeat the procedure.

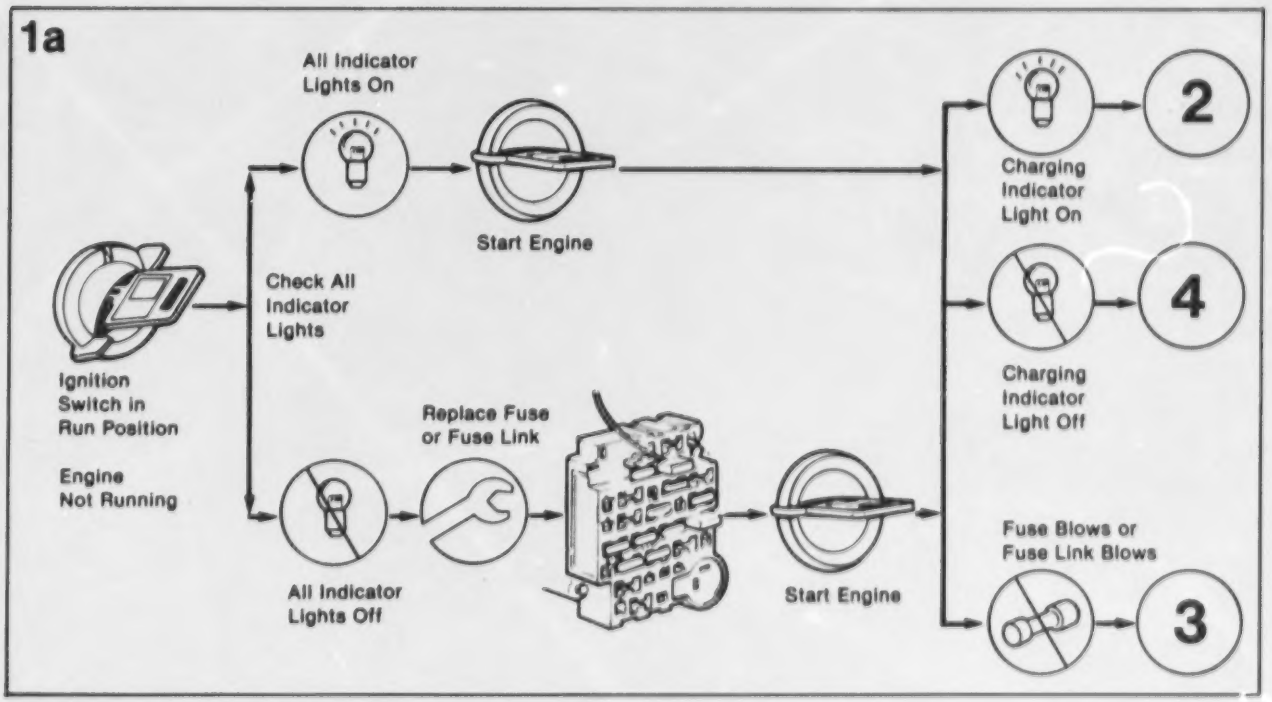
Let's take an example. Look at the chart below.

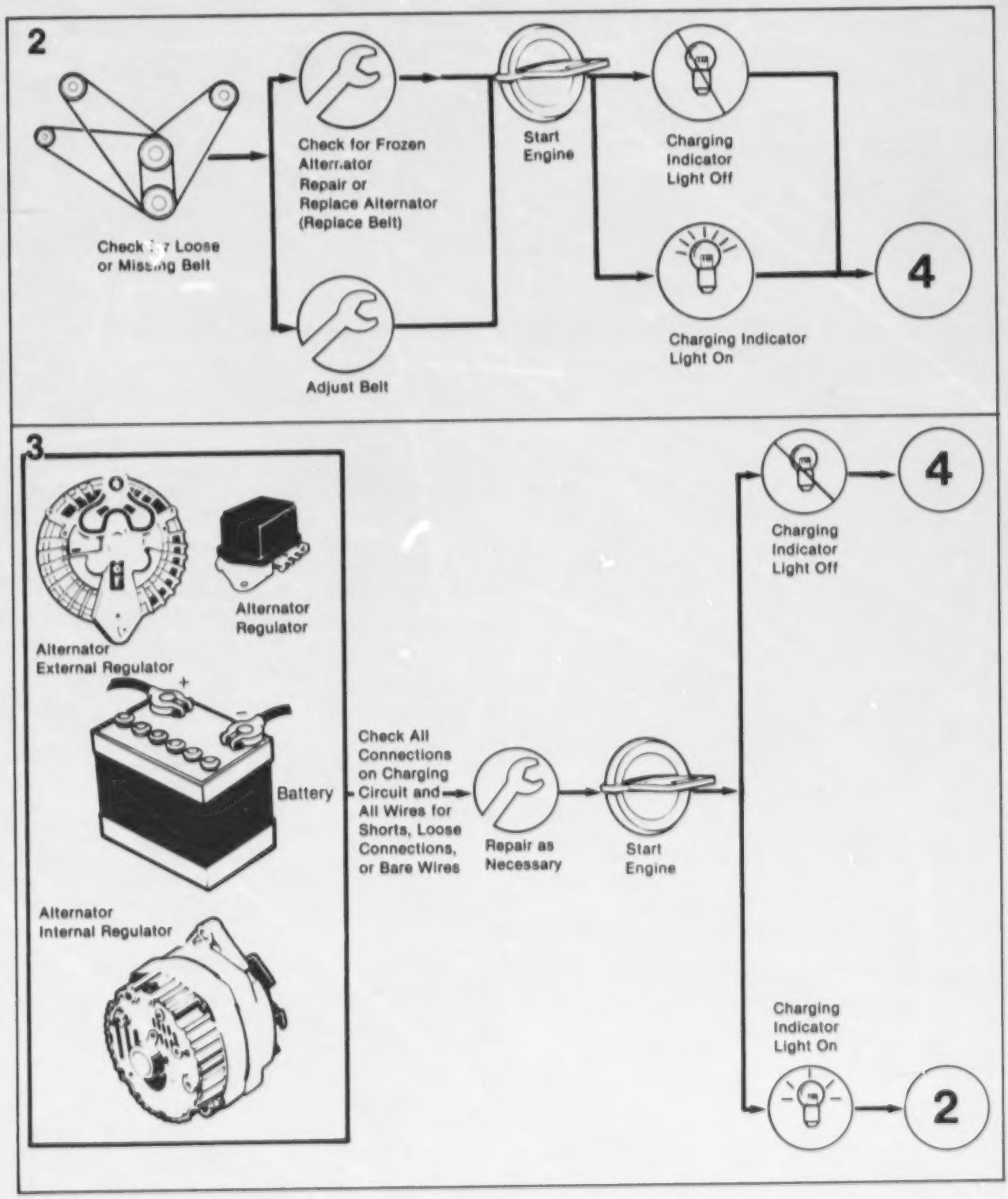

Ignition Off
Charging Indicator Light On
Repair Short in Wiring; Repair or Replace Alternator, Regulator, or Ignition Switch
Repeat Test
Charging Indicator Light On
Charging Indicator Light Off
Charging Indicator Light Off
4

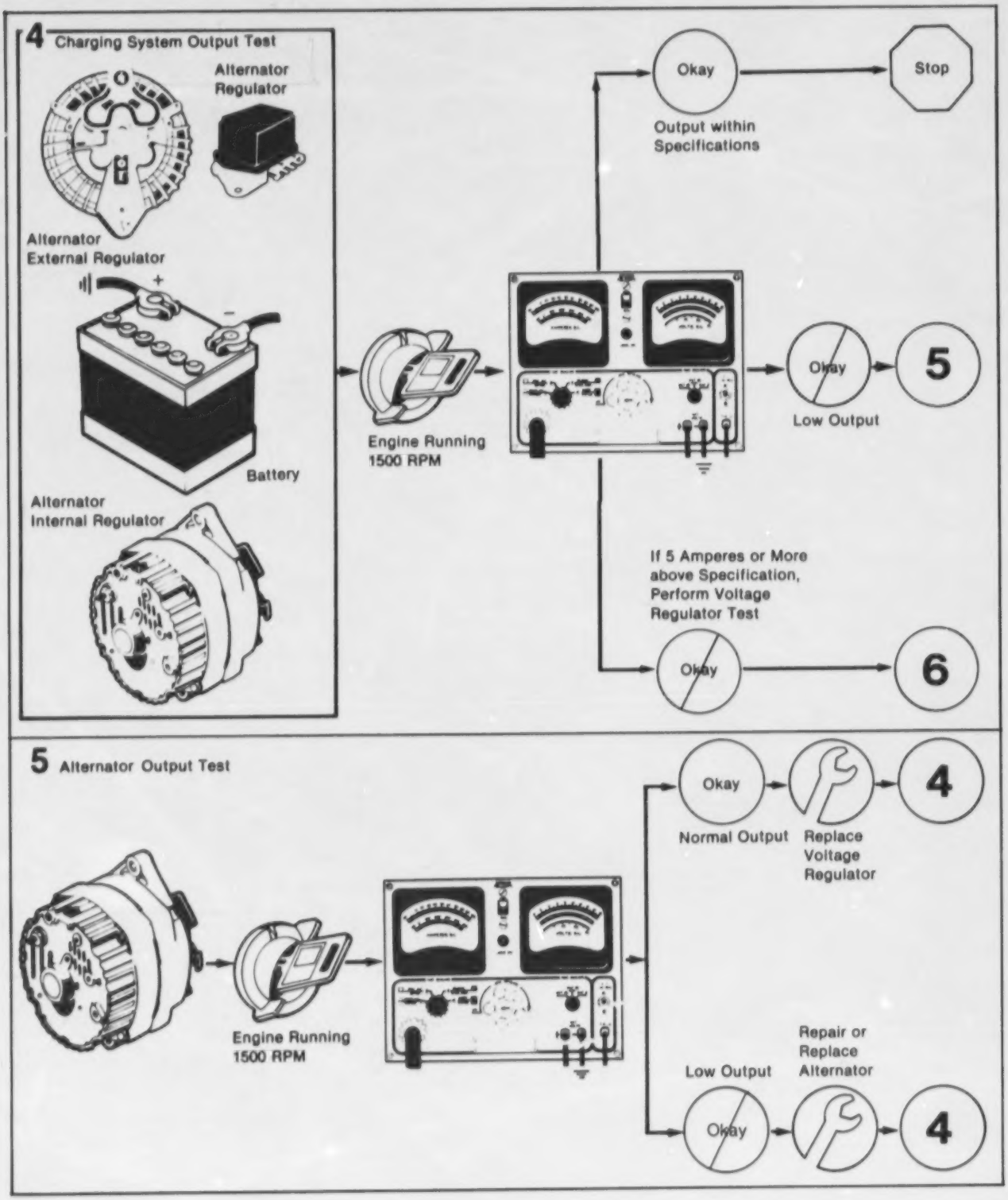


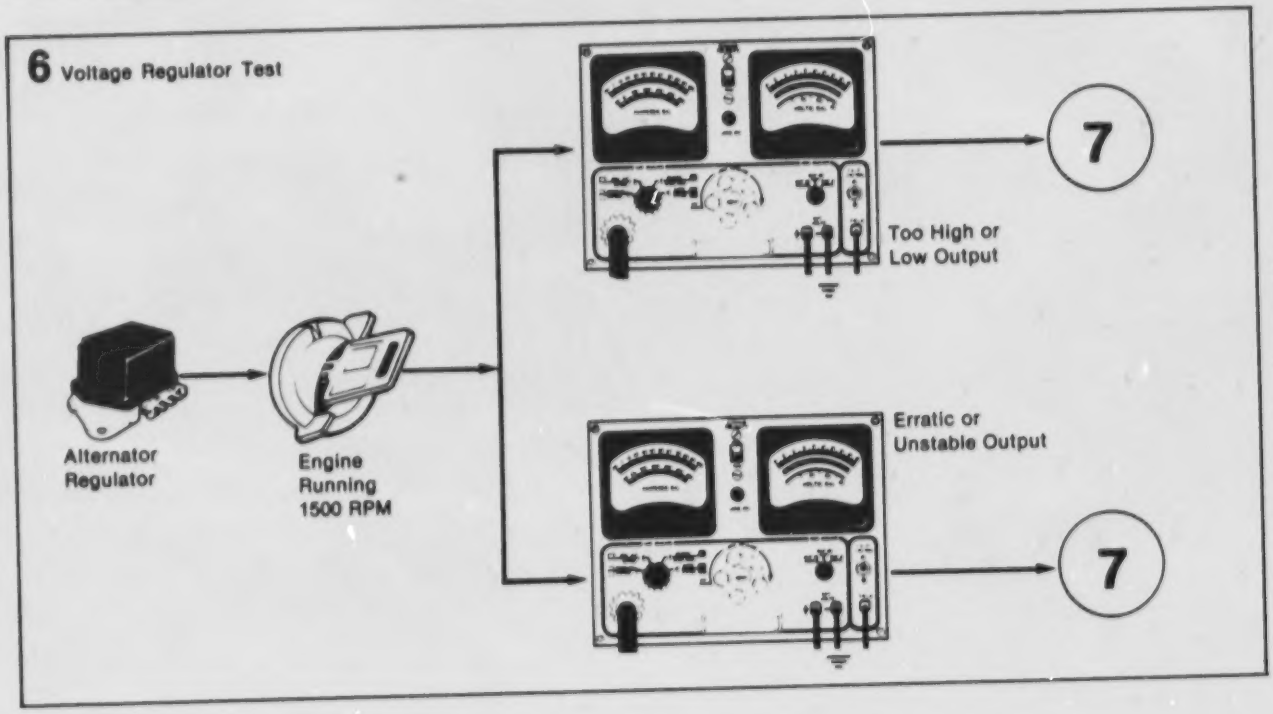
Step 1a consists of quickly checking the charging system indicator lights with the ignition switch in the *RUN* position. Check all indicator lights (alternator, oil, and cooling). If the lights are *on,* start the engine and check the charging indicator lights. If they are still on, go to step 2. If they go out, go to step 4.

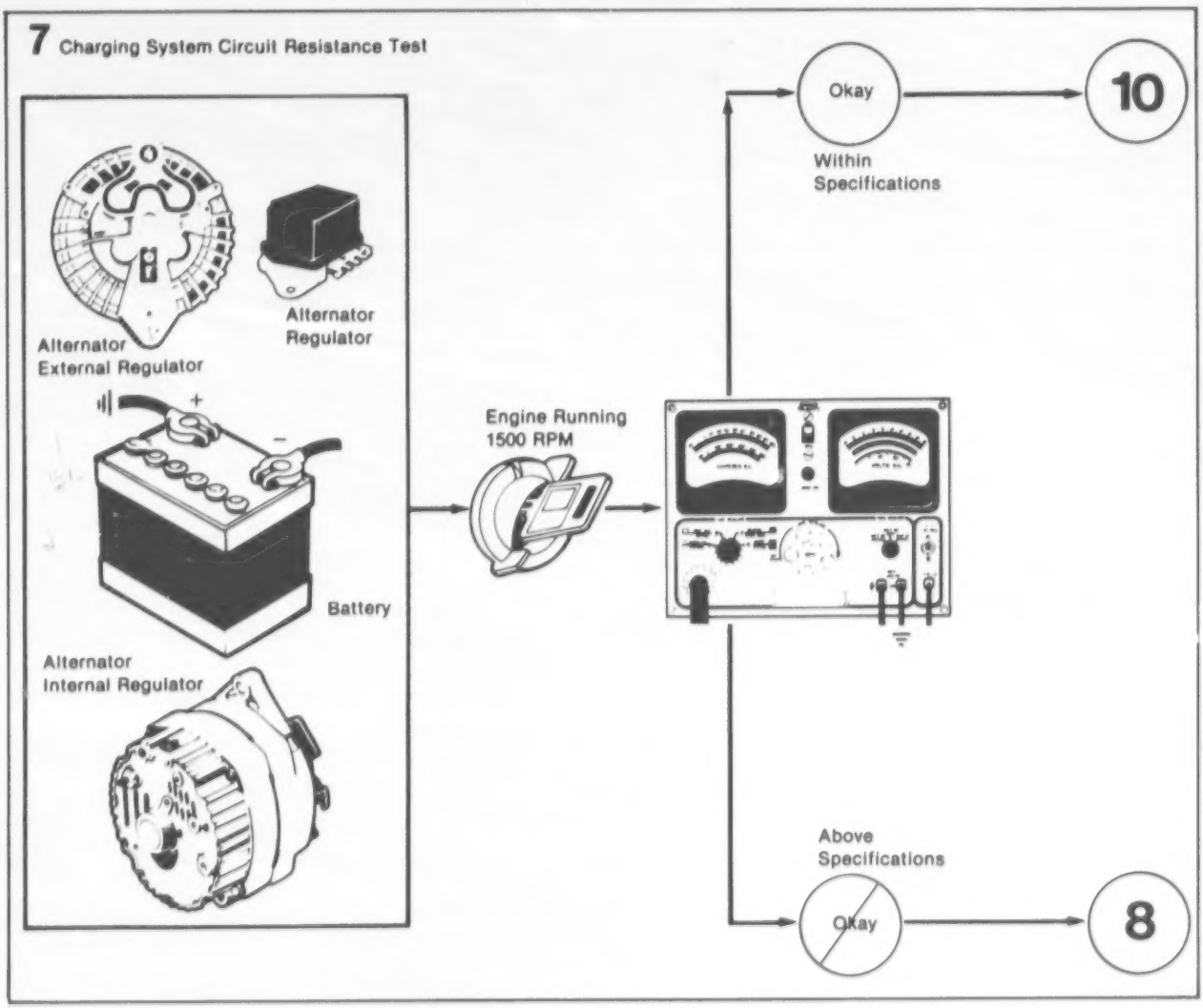
Now go back to checking all of the indicator lights. If a light stayed off, replace the fuse or fuse link. Start the engine. If the light still won't come on, go to step 4. If the fuse or fuse link blows, go to step 3.



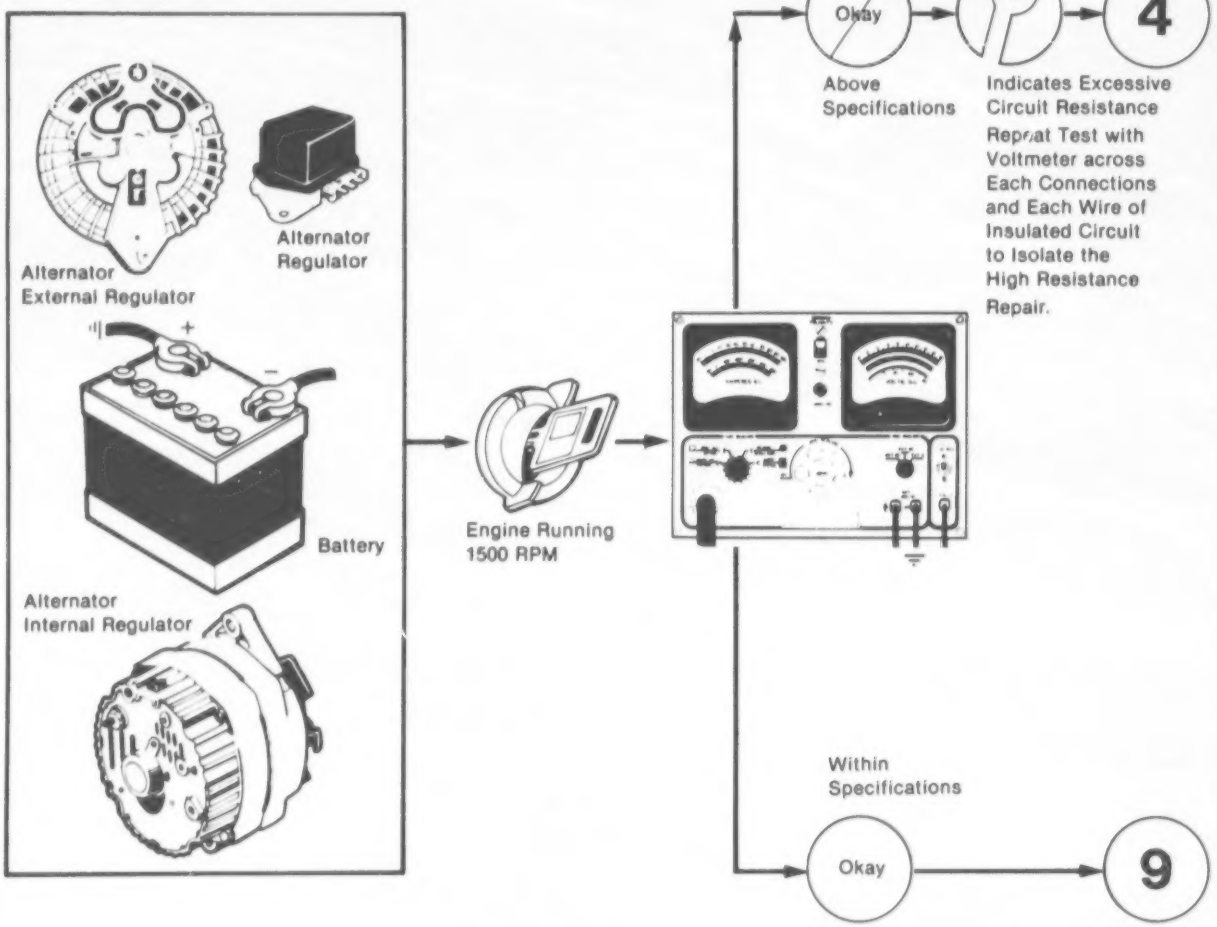

2
Check for Loose or Missing Belt
Check for Frozen Alternator Repair or Replace Alternator (Replace Belt)
Adjust Belt
Start Engine
Charging Indicator Light Off
Charging Indicator Light On
4
3
Alternator External Regulator
Alternator Regulator
Battery
Alternator Internal Regulator
Check All Connections on Charging Circuit and All Wires for Shorts, Loose Connections, or Bare Wires
Repair as Necessary
Start Engine
Charging Indicator Light Off
4
Charging Indicator Light On
2


4 Charging System Output Test
Alternator Regulator
Alternator External Regulator
Battery
Alternator Internal Regulator
Engine Running 1500 RPM
Okay
Output within Specifications
Stop
Okay
Low Output
5
If 5 Amperes or More above Specification, Perform Voltage Regulator Test
Okay
6
5 Alternator Output Test
Engine Running 1500 RPM
Okay
Normal Output
Replace Voltage Regulator
4
Low Output
Repair or Replace Alternator
Okay
4

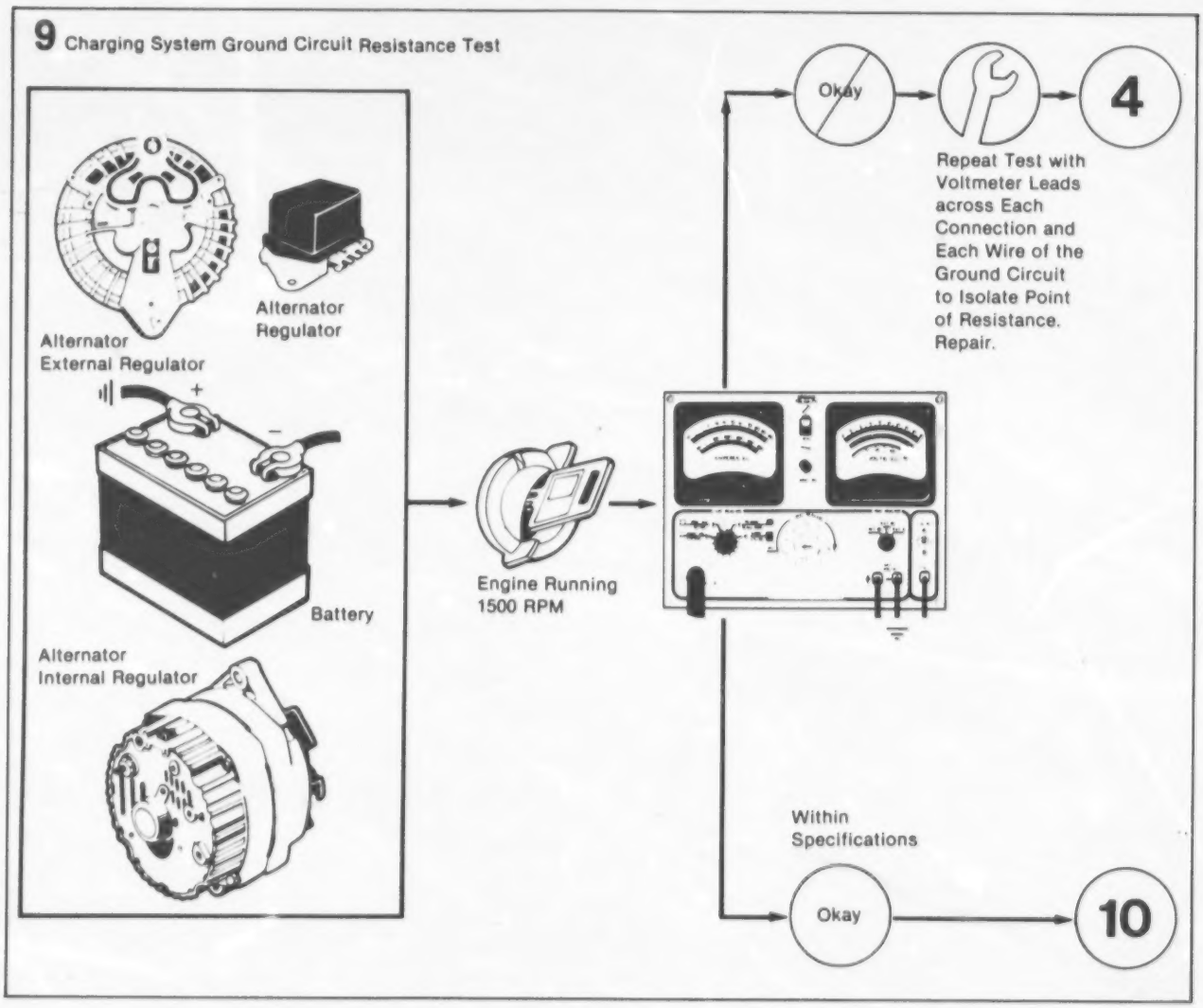

6 Voltage Regulator Test
Too High or
Low Output
7
Erratic or
Unstable Output
7
Alternator
Regulator
Engine
Running
1500 RPM


7 Charging System Circuit Resistance Test
Okay
10
Within
Specifications
Alternator
Regulator
Alternator
External Regulator
+
–
Engine Running
1500 RPM
Battery
Alternator
Internal Regulator
Above
Specifications
Okay
8

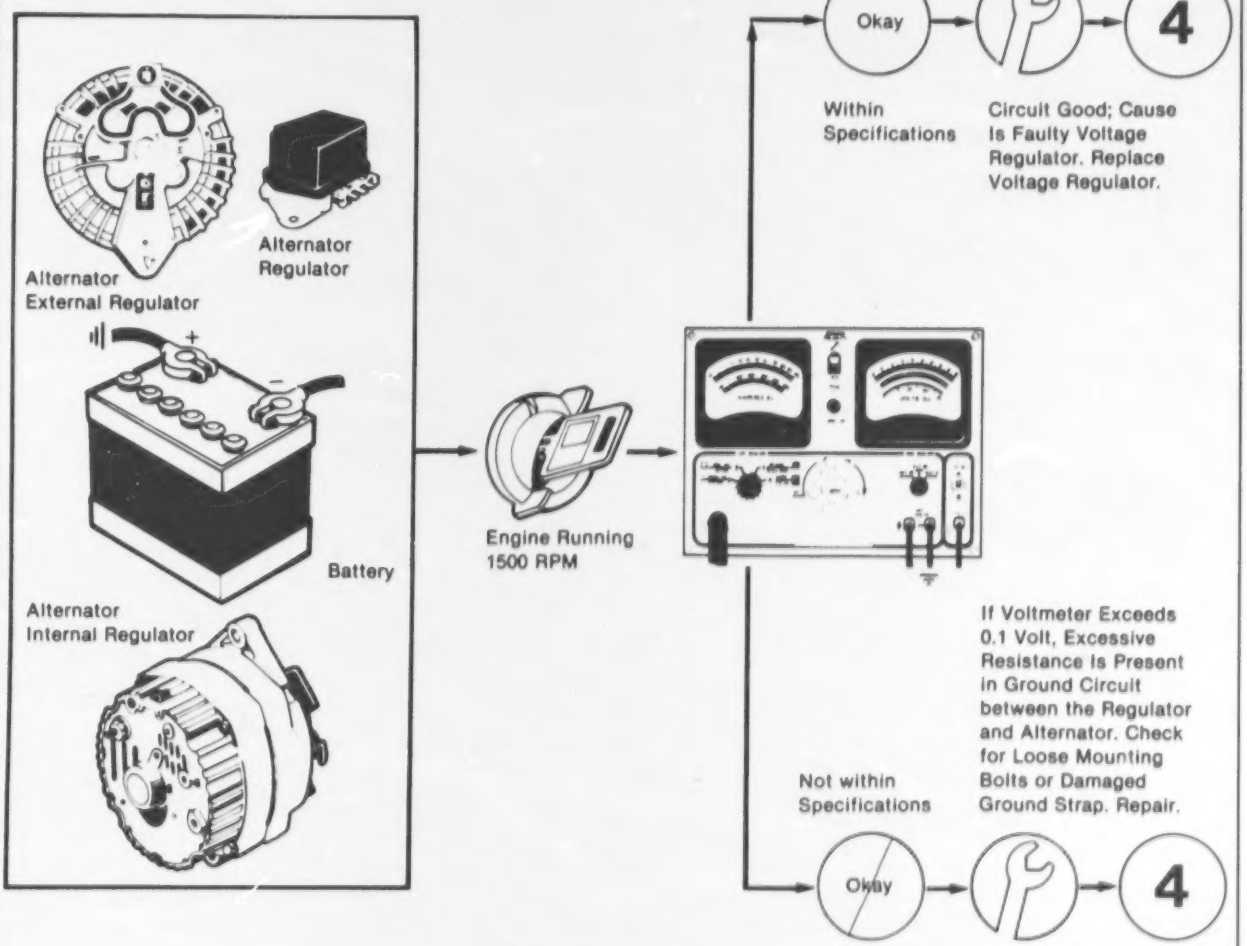
8 Charging System Insulated Circuit Resistance Test



9 Charging System Ground Circuit Resistance Test



10 Voltage Regulator Ground Circuit Resistance Test



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